POWER

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The Jetsam of Progress

RECENT news reports announce numerous examples of the aggregation of business and industrial interests toward which the trend of recent years has been so decided.

Not only is the local artisan crowded out by the factory product, but the factories themselves become but units in great national or international consolidations.

The small producer and the moderate-sized plant are crowded to the wall or absorbed by gigantic combinations of brains and capital.

All of which is the natural process by which civilization takes advantage of improved facilities of communication, production, transportation and distribution.

And such large-scale operations with their economies of aggregation and diversification, their avoidance of waste and their reduction of overhead and personnel should be better for all concerned.

But, by and large, every real economy that is effected means a reduction in the demand for human labor, and while, in the long run, it means less human effort for the maintenance of the race upon a given scale, it does involve confusion and hardship for those whose occupations and opportunities are sacrificed in the process.

The announcement of the recent consolidation of three large concerns rang with statements of its advantages to their stockholders and to the users of their service.

But a peep behind the scenes is afforded by the human concern for his less fortunate associates expressed by the man who has been selected to operate the combination.

If the advantage of reduction of personnel is to be realized, men who have devoted their lives to the development of the constituent companies and who had a right to consider that they had earned for themselves an established status must be jetisoned.

Many are too far advanced in years to start anew. To most, if not to all, it means a disastrous setback.

It is a problem that came in with labor-saving processes and machinery. There should be some way by which men in such position should be relieved from the imposition of so large a proportion of the cost of the benefits of the change.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

The Responsibility of the Power Producers

WITHOUT question the prosperity of the power producers is inseparably linked with the welfare of our country, and the readers of *Power* realize their part of the responsibility to maintain it. Of the economic forces which form the very foundation of this welfare, none is more fundamental or sensitive than confidence. Without it the industrial structure will waste and take into its wake an era of depression as real as it may be unjustified.

Recognizing this, Mr. Hoover, while Secretary of Commerce, commenced a thorough investigation of the subject and has carried the work on continually since his election to the Presidency. His recent conferences with railway, industrial, labor and commercial executives are further steps in the same direction and should not be regarded as evidence of a critical business condition.

That the conferences have followed the recent stock market recession is recognition of the necessity for promptly removing possible doubt in the minds of the uninformed as to the fundamental soundness of our institutions and their future plans. If confidence is absent, it is characteristic caution for industry to suspend operations that require capital investment until a clear horizon is apparent in other directions, although within the industry itself there may be no justifiable reason to feel uncertain as to future prospects.

The withdrawal of business thus innocently started by one is promptly followed by others until the lack of confidence never actually justified has become a real menace to our economic well being.

In avoiding such situations the constructive leadership of the President has been of the greatest benefit. But the maximum result will not be achieved unless the power producer readily accepts his portion of the responsibility along with the railroads, the producers and the distributors.

With the present abundance of money at low cost, aggressive leadership is favored with an unusual opportunity to initiate new construction or modernize existing construction.

Industrial Costs Need Attention

WHILE conferences are being held almost daily for the purpose of determining what can be done to prevent a slowing up of industry and the bad times that would follow, it is well not to lose sight of the other paths that lie open to improved economic conditions. At least as much good will come from decreasing the cost of doing the present volume of business as may be expected from a heightened activity. So it is important that there be no slackening in the attempt to cut costs of production and distribution.

Much, of course, has been done along these lines since the appearance of the memorable report on the elimination of waste in industry. Yet much remains to be done. In the field of the use of power services alone there are still great advances to be made.

Consider the use of light. In spite of all the work that has been done to improve industrial lighting there are still hundreds of factories in which inadequate illumination slows production and increases costs.

Think of the lack of material-handling equipment in most plants. Even though the mechanical handling facilities of some outstanding plants have attracted general attention, it is still true that most materials within factories are moved by hand instead of by power.

Or again, ponder upon the use of automatic production machinery. Regardless of the great savings made by those who have substituted the machine for the man, hand labor is still considered necessary in many quarters.

It would be possible to greatly extend this list of production wastes. Beyond that, as many more wastes could be pointed out in distribution. But it is with the production end of industry that the power engineer should be particularly concerned. For there, by a judicious promotion of the use of his product—power service—he can do much to keep industry on the path of progress through a reduction of costs that will increase profits and facilitate expansion.

Nuisances Need Not Accompany Industry

"WHAT a riot life is today," says the man who loves peace and tranquillity. There was a time when he could get away for a quiet afternoon, breathing clean air in silent contemplation. But today, his ears are assailed by confused noises, his nostrils are befouled by smoke and irritated by dust, and his clothing is soiled by soot and grime. And all because of the advance of industrialism, he thinks. So this man reviles the industrial order.

Little does he realize that the same industrial order has given him the telephone, the railroad trains and the automobile which make it easy for him to travel further in less time and with more comfort; the electric light and countless comforts and conveniences that he has come to accept without thought as the necessities of life.

At the same time, the engineer who has this industrial

order in his keeping must realize in a far more significant fashion than he has, that the accompaniment of noise, smell, dust and smoke is by no means an essential part of the hum of machines. Industry must be conducted in a manner that will avoid the creation of nuisances. The law steps in now and then and orders the abatement of a nuisance, and perhaps awards damages, and sometimes an industrial organization is forced into the position of defending itself against absurd and unjust accusations. But industry must go far beyond this. It must go the law one better and so conduct its activities that they are above criticism.

Can this be done? That is a question the engineer must answer. It calls for much thought, experiment, and a patient determination to find a way. It will cost money in many cases, but is it not a legitimate charge on industry? Finally, it now and then develops that the incidental improvements result in savings that more than offset their cost.

When Operation Starts —What Then?

WHEN heat is produced it must be dissipated or the temperature will eventually reach destructive values. Every engineer appreciates this simple fact, but for some reason fails at times to take it into consideration in his designs. Electrical equipment of every kind liberates heat, and if the temperature of the surrounding air is to be maintained at a reasonable value, proper ventilation must be provided. This is particularly important with machines of large capacities.

In the design of office and other buildings, careful consideration may be given to ventilating almost every part of the structure except the elevator machinery rooms. These rooms frequently contain high-powered motors, generators and controllers, the losses from which are given off in the form of heat. One kilowatt-hour expended in heat will raise the temperature of one thousand cubic feet of air approximately twenty degrees Fahrenheit. Consider five elevator machines in a room, each machine requiring ten kilowatt-hours per hour of operation. If fifty per cent of this power is represented in the losses to the machines, then twenty-five kilowatt-hours equivalent of heat is liberated in the room per hour. This heat will raise the temperature of twenty-five thousand cubic feet of air approximately twenty degrees. It is obvious that unless this heat is removed from the room the temperature will quickly become excessive.

To this must be added the condition that exists when the elevator room is on the top of the building under a glass roof. Without any heat produced in the room, the sun's rays on a hot summer day will make the room's temperature excessive. Notwithstanding these simple facts, elevator machine rooms often have no ventilating facilities whatsoever, not even a window that can be opened. Under such conditions electric machines cannot operate very long without roasting out.

This oversight on the part of designers is generally not discovered until after the building has been turned over to the owners. Then it becomes the operating engineer's problem to solve the difficulty as best he can. This usually involves many times the cost the work could originally have been done for, and at best the final job will probably be a makeshift. To be successful a design must take into account the small feature as well as the large. Too frequently small things are overlooked that must be changed or provided for when operation starts.

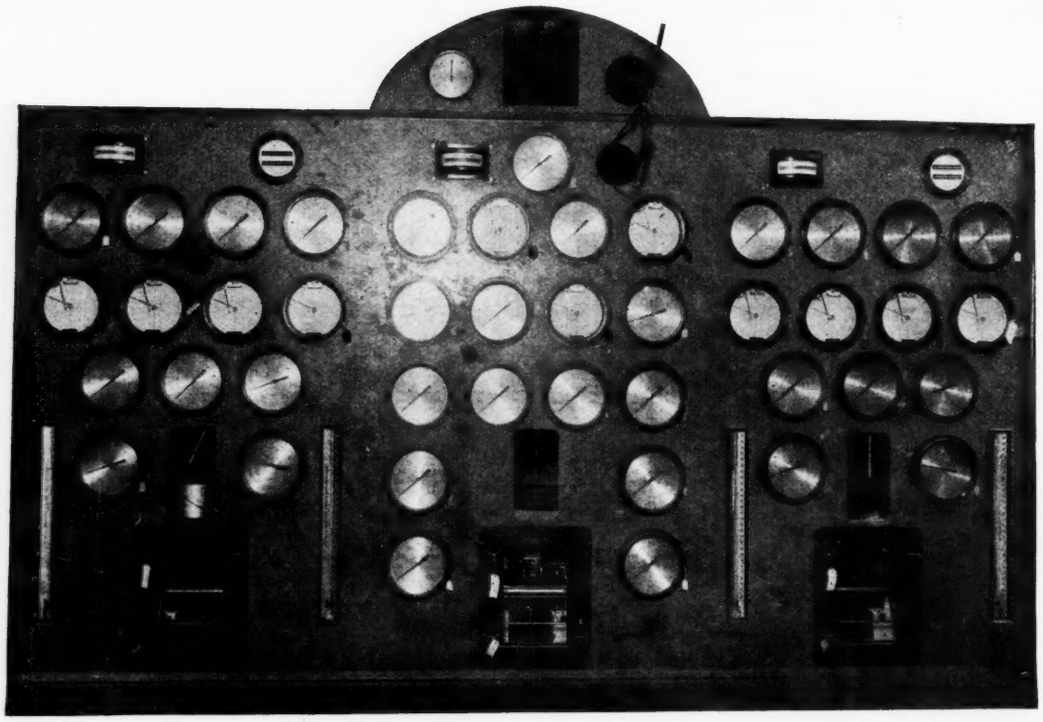
Outwitting Obsolescence

WHEN is a machine obsolete? Answer: On the day the market offers another machine whose additional effectiveness will justify the cost of junking the old for the sake of the new. This, in extreme cases, may happpen in the first year of a machine's life. Or, at the other extreme, it may run for twenty or thirty years and wear itself out before it is overtaken by obsolescence. On the average, power equipment becomes obsolete in ten or fifteen years.

Obsolescence, like death, is a condition that cannot be remedied after it arrives. If a machine is obsolete, that is the end of the matter as far as economic operation is concerned. But forethought may often defer obsolescence, just as it prolongs human life.

In the case of machines this foresight must be applied when the purchase is made. Yet that is just the time when the ultra-conservative buyer is likely to defeat his own aim of "safety first" by demanding equipment with a long record of reliable service. He says "this is the engine or boiler for me. For ten years (or twenty or thirty), without change in design, it has 'delivered the goods.' Such a purchase surely insures the buyer against mechanical or operating defects, but he pays for this certainty even though the price may seem reasonable enough. Ten years on the market without design changes means nine years handicap in the obsolescence race with his competitor who is satisfied with a machine that has proved itself in operation for one year. It takes better judgment to evaluate the new, but those who have this judgment, and apply it, gain a tremendous advantage by adding a known period of five or ten years to the unknown total span of economic life.

Japan, last month, was host to the outstanding engineers attending the World Power Conference and the World Engineering Congress and has extended to the visitors a hospitality typical of Eastern thoroughness. Here, in a setting strange to most of the delegates, the engineers met to discuss and exchange views on problems of mutual interest and to learn of advances made in other countries. A report of the technical sessions of the conference is given in this issue and from it may be gleaned something of the extent and success of these meetings. It is from the international contacts which conferences such as these afford that much of today's progress has grown.



Turbine room gage board

Turbine Room *Features at* State Line Station

Turbine governing and the precautions taken to guard against accident are of unusual interest

IN *Power* of Oct. 29 the features of State Line Station as a whole were outlined, and mention was made of the 208,000,000-kw. G. E. turbine-generator. Additional details on this great machine and its auxiliaries should be of interest. Some conception of its capacity will be seen from the fact that the unit can furnish sufficient energy to light 3½ million standard 60-watt lamps, or light 100,000 average homes with all of the lamps in each house illuminated. The machinery comprising this group-unit weighs about 4,000,000 lb., the heaviest individual part weighing 274,000 lb.

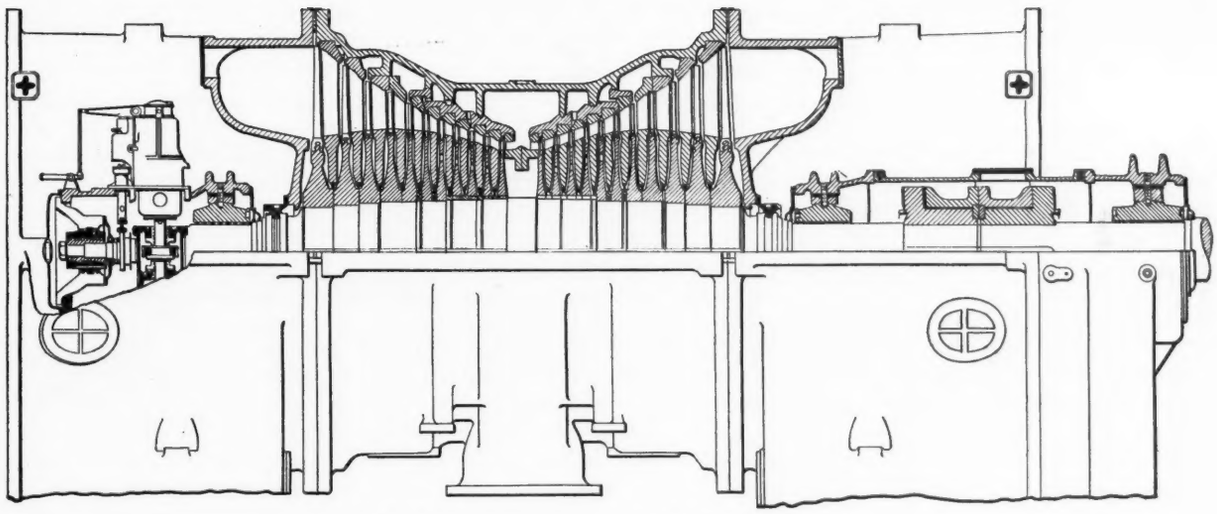
Three elements, a 76,000-kw. high-pressure, centrally located, with a 62,000-kw. low-pressure machine on either side, make up the unit. The additional 8,000-kw. comes from two 4,000-kw., 2,300-volt house generators, one mounted on the shaft of each low-pressure machine. All three elements of the unit operate at 1,800 r.p.m. and generate 3-phase 60-cycle current at 22,000 volts. The high-pressure prime mover is a 17-stage single-flow impulse turbine. Each low-pressure turbine is of the double-flow type, with 11 stages on either side of a central admission.

Steam enters the throttle at 600 lb. and 730 deg. F. To maintain a flat efficiency curve, steam at full throttle pressure may be admitted to the high-pressure turbine at four points, two in the first-stage nozzles, another in the third-stage nozzles and the fourth in the ninth-stage nozzle. With the machine operating at full load, steam leaves the high-pressure element at 115 lb. abs., and at a temperature approximating 400 deg. F. The flow divides into two streams, each passing through a live-steam reheater, where the temperature is raised to 500 deg. by steam from the main supply line. From each reheater the steam goes to a low-pressure turbine. Here the flow again divides, each half of the supply passing through its respective end of the machine, where for the third time it is subdivided and is directed into two vertical single-pass 22,000-sq.ft. condensers. There are thus four condensers for each low-pressure turbine, or a total of eight condensers for the unit, having a total cooling surface of 176,000 sq.ft. They were designed to condense 1,600,000 lb. of steam per hour when supplied with 380,000 gal. of water per minute. This amount of cooling water is furnished by four vertical circulating pumps located in a crib house at the intake.

Cooling water enters each condenser through the lower water box, rises through the tubes and overflows through passages cast in the shell to the discharge tunnel. The tubes are rolled into the heads at both ends, and as the latter are fixed in position, expansion is taken care of by bowing the tubes.

These condensers function separately except in air removal. The two first-stage air jets on each of the two condensers, serving one end of a low-pressure turbine, discharge to a common inter- and aftercooler. The latter is equipped with three second-stage jets, so that sixteen first-stage and twelve second-stage jets serve the eight condensers on the two low-pressure turbines.

The performance diagram, made up for a load of 150,000 kw. on the triple unit, shows an efficiency of



Double-flow low-pressure turbine in part section

13,420 B.t.u. per kilowatt-hour. The level of condensate in the condenser hot well is maintained by float controls that regulate the supply from an interconnected hot-water reservoir. Rising of the water in the condenser hot well to a predetermined point opens a valve that admits water from the system into the reservoir. If the water in the hot well recedes, a float opens the interconnecting valve, so that water passes from the reservoir into the hot well.

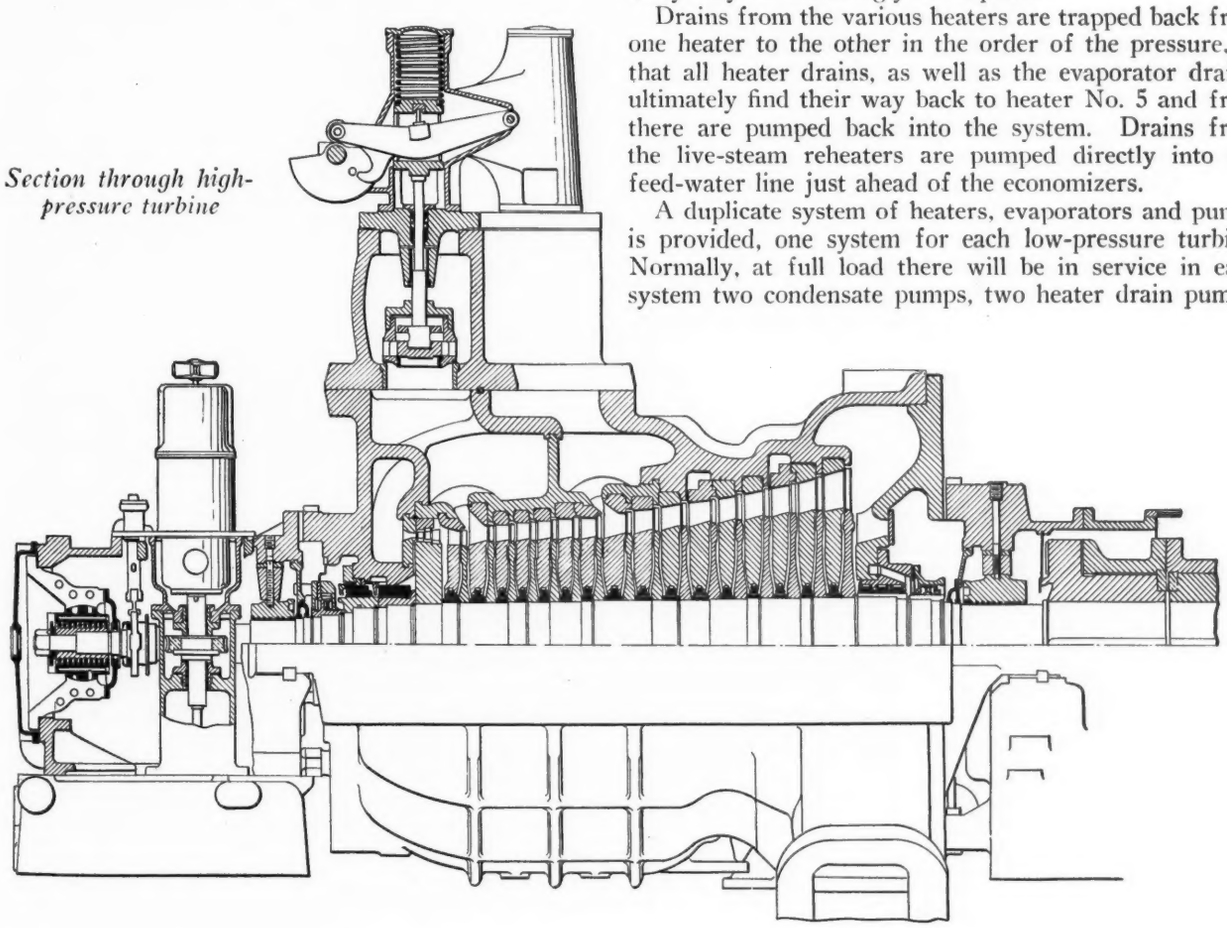
Bleeding of steam from the turbine to heat the feed water has been carried to an unusual degree, as there are five points of extraction leading to five closed heaters. The temperatures and quantities involved for the particular load on the turbine appear on the diagram. From the final heater in the series the water enters the boiler-feed headers at a temperature of 380 deg., passes through excess-pressure and water-level regulators and enters the economizers, to leave in the form of steam through a series of tubes to the boiler drum.

All make-up water is provided by two vertical contra-flow evaporators for each low-pressure turbine, using bled steam at approximately 30 lb. absolute, or exhaust steam from the turbine-driven boiler-feed pump. The evaporators are arranged for single-effect multiple operation, and exhaust their vapor direct to a single evaporator-condenser using the boiler feed as cooling water. They may be used singly or in pairs.

Drains from the various heaters are trapped back from one heater to the other in the order of the pressure, so that all heater drains, as well as the evaporator drains, ultimately find their way back to heater No. 5 and from there are pumped back into the system. Drains from the live-steam reheaters are pumped directly into the feed-water line just ahead of the economizers.

A duplicate system of heaters, evaporators and pumps is provided, one system for each low-pressure turbine. Normally, at full load there will be in service in each system two condensate pumps, two heater drain pumps,

Section through high-pressure turbine



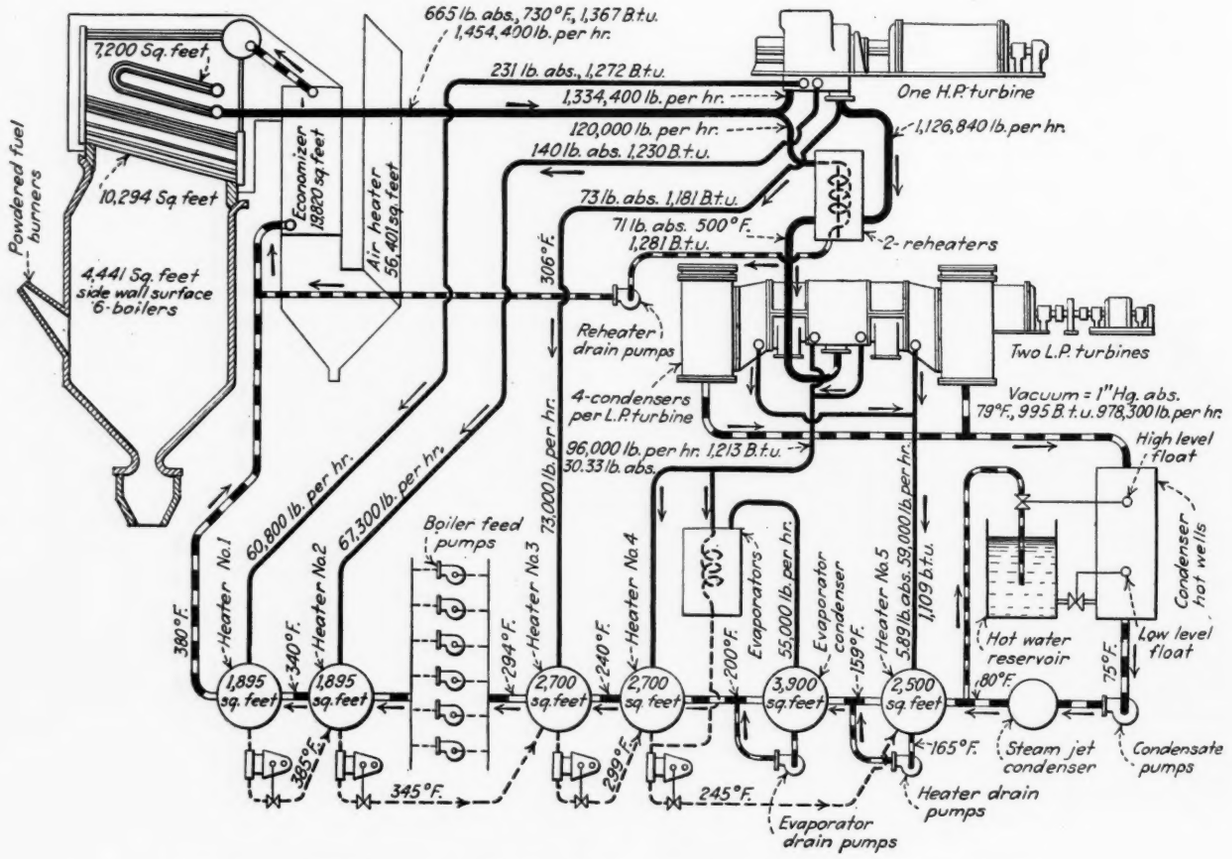
one evaporator-condenser pump and two motor-driven and one turbine-driven boiler feed pump.

Venturi meters are in the main condensate lines, in the discharge lines of the heater and evaporator condenser drain pumps and in each main feed line to each boiler. All individual auxiliary electrical equipment is separately metered to provide a proper check on auxiliary power. Provision is made for measuring the purity of evaporator distillate and condenser leakage, and filtered water is supplied to the evaporators through cold water disk-type meters, one for each evaporator shell. In fact, the instrument and meter equipment is so complete that it is possible to maintain a continuous running test on the performance of all equipment.

To give maximum flexibility to this triple unit, and at the same time provide the same degree of safety as obtained with smaller machines, special provisions were made for governing the speed of each element, a number of protective devices having been added to guard against every contingency. Normally, the entire machine is designed to operate as a compound unit. The high-pressure turbine may operate with either one of the low-pressure turbines; or either or both low-pressure machines may be operated on high-pressure steam without the high-pressure turbine. The arrangement last named would not be economical, so the low-pressure elements will be operated independently on high-pressure steam only in emergencies.

To properly govern the triple unit and provide the usual double protection for each of the elements, the vided. Briefly, operation of each machine is controlled by a flyball governor geared to the turbine shaft, which, through a pilot valve, controls the admission of the oil to a hydraulic cylinder that manipulates a control valve in the main steam supply line. The oil is pumped to a pressure of 125 lb. and at that pressure is admitted to the hydraulic cylinder to open or close the control valve, as dictated by the governor functioning through the pilot valve. The oil from the hydraulic cylinder passes through an oil cooler and is throttled down to 30 lb. pressure before it is delivered for bearing lubrication. High-pressure steam to each element of the unit is controlled in the same way, and in addition an emergency governor is provided to trip the throttle valve through an oil cylinder.

The foregoing is standard practice on machines of the same make. Additional protection has been provided to guard against accident in any combination of turbine elements that may be used. A standard automatic vacuum trip operating two oil pilot valves protect each low-pressure turbine against loss of vacuum. Should the vacuum drop to 17 in. or less, the device is tripped and a dropping weight operates both oil pilot valves. One of these valves is installed in series with the oil supply to the intercepting valves on either side of the live-steam reheater, and the other pilot valve is in series with the throttle valve oil-trip cylinder. Loss of vacuum, therefore, closes the intercepting valves between the high-pressure and the low-pressure turbines, and also the governor gear indicated in the diagram has been pro-



Performance diagram of triple turbine unit computed for load of 150,000 kw.

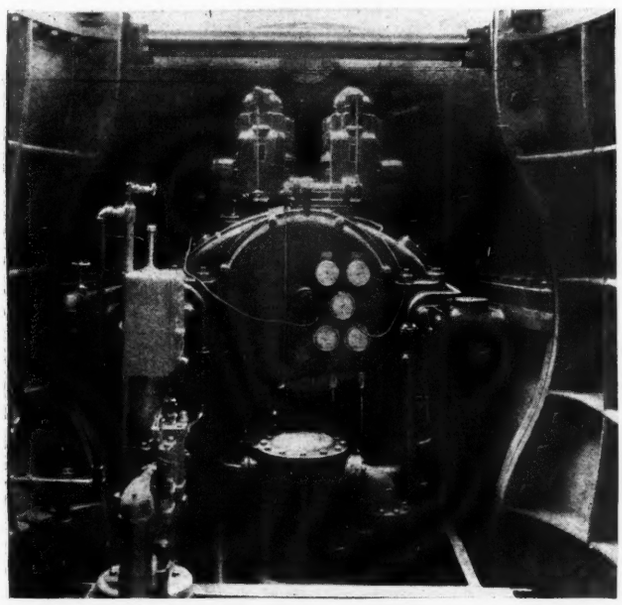
Heat rate: Turbine 9,850 B.t.u. per kw.-hr.; auxiliaries, 650 B.t.u. per kw.-hr.; total 10,500 B.t.u. per kw.-hr. Boiler room efficiency, 85 per cent; operating efficiency rating, 92 per cent; station, 13,420 B.t.u. per kilowatt-hour.

10-in. double-beat stop valve *E* in the live steam supply to the low-pressure machine, its oil supply being in parallel with that of the intercepting valves. Should the pressure rise in the condenser system to 2½ lb. before a vacuum of 17 in. has been reached, as in starting, another trip operates the pilot valves that close the throttle and intercepting valves.

In case of failure of the foregoing protection, or of a pressure rise in the condenser system after the valves have been closed, rupturing diaphragms of 24-in. diameter, one to each condenser, have been provided and are set to "blow" at 5 lb. gage.

High-speed, special, parallel-seated, intercepting gate valves, one on either side of each reheater, perform the double function of shut-off and emergency quick-closing valves. They are operated by a 10-in. hydraulic cylinder to which the boiler feed supply is admitted under the control of a 3-in. pilot valve, which, in turn, is operated by the oil pressure on the low-pressure turbine. When the oil pressure is normal, about 100 lb. gage, the pilot valve is held open against spring pressure and the boiler feed-water pressure in the 10-in. hydraulic cylinder holds open the intercepting valve. In case of failure of the oil supply, the spring closes the pilot valve and allows the feed water to close both intercepting valves.

Referring to the diagram, valves *A* and *D* will remain closed until a hand-reset valve in their oil supply is operated, while valves *B* and *C* will reopen immediately upon restoration to normal of the oil supply pressure. These



Governor and control on a low-pressure turbine

valves have a special venturi throat section 24 in. in diameter in both the 32 and 36 in. sizes. Their average time of closing is 1½ sec. from the start of the trip.

As the intercepting valves are not directly operated by the turbine oil pressure, but use intermediate pilot valves to control the boiler-feed water, it was thought necessary to install just ahead of the low-pressure inlet nozzle, a balanced stop valve directly operated by a spring. Pressure on the piston of its oil cylinder compresses the spring and opens the valve upward. The valve is quickly closed by the spring if the oil pressure fails. This valve may be operated by the pre-emergency governor, by the emergency governor or by the vacuum tripper.

To protect the high-pressure turbine when, with all three elements in service, the low-pressure turbines for any reason close their inlet valves, there are four relief valves on the high-pressure exhaust piping. They are set to "blow" in succession at 5 lb. intervals from 120 to 135 lb. gage by electrical solenoid action, automatic with the steam pressure. In case the electrical action fails, an emergency mechanical tripper operates on all four valves at 140 lb. pressure. Each valve has a relieving capacitiy of 500,000 lb. of steam per hour at 120 lb. pressure.

Auxiliary power at 2,300 volts comes from the two 4,000-kw. house generators on the low-pressure turbine shafts and from either one of two 9,000 kw. transformers connected to the system. The auxiliary generator

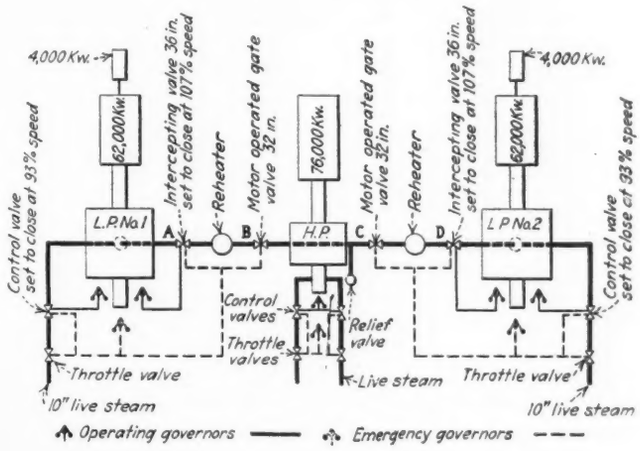


Diagram of governor gear protecting the three elements of the turbine

leads are lead-covered, varnish-cambric-insulated cables carried to metal-clad switchgear mounted at two different elevations adjacent to the wall between turbine and boiler rooms. The bulk of the auxiliary power is used by the large motors of the station at 2,300 volts. For certain of the smaller motors the voltage is reduced to 440 and 220.

For auxiliary drive there are over 225 alternating-current motors with an aggregate capacity of 25,000 hp., the largest being the 750-hp. motors driving the boiler-feed pumps. In addition there are 80 direct-current motors totaling more than 950 hp. that obtain their energy through 17 motor-generator sets. Two storage batteries, each having a capacity of 100 kw.-hr., provide an independent source of power for operation of the station controls.

Control of the electric generating equipment is centered in an operating room located on the same floor as the generators but separated from them by glass partitions. A complete system of automatic telephone, signals and annunciators keep the operator informed of conditions in the turbine room.

The conventional switch house or switching room, with its multiplicity of concrete compartments and cells, has been supplanted in this station by an outdoor switch yard of original design in which the main electrical switching equipment, the main 22,000-volt busbars, the oil circuit breakers and their connections are supported on a series of open steel frameworks. All live parts are inclosed in a series of grounded metal pipes and junction boxes, so that it is impossible to come in contact with the high-

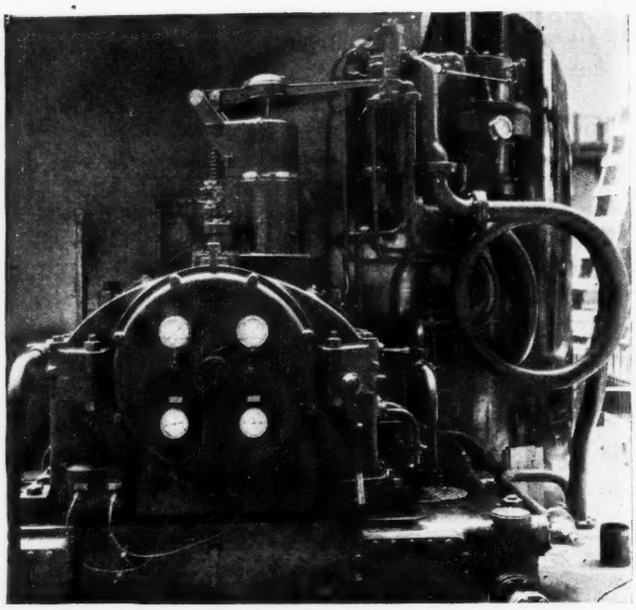
voltage conductors. Each of the three phases has its own independent set of housings to prevent a direct short-circuit between phases. The live parts of reactors and transformers are inclosed in grounded metal tanks, and all interconnections between the switching structure and the reactors and transformers are made with single-conductor insulated cables having grounded lead sheaths.

Circuit Breakers Easily Handled

In the switch yard there is a traveling elevator by means of which any oil circuit breaker may be lowered either to the "disconnect" position, where its tank may be removed for inspecting the contacts, or completely lowered so that it may be removed by transfer truck into the building for a more complete overhauling. This method of handling circuit breakers has made possible the elimination of disconnecting switches and provides a simple and effective system of interlocking to prevent injury to attendants engaged in maintenance work.

From the generators to the outside metal-clad switchgear all main circuits are carried through duplicate sets of oil circuit breakers of 2,000,000 kva. interrupting capacity to duplicate 22,000-volt outdoor closed-ring buses. Each double-ring bus is divided into three sections, one generator supplying each section, with suitable reactors and oil circuit breakers between sections. As future units are added, another bus section will be placed in the ring for each additional generator.

As all power sent out from the station is transformed to a higher voltage, each outgoing feeder is equipped with a water-cooled transformer bank or a three-phase water-cooled transformer. At present there are eight high-tension circuits leaving the station, as follows: Three 66,000-volt lines of 60,000 kva. each; two 132,000-volt 60,000-kva. circuits, and three 33,000-volt circuits, each of 2,000 kva. capacity.

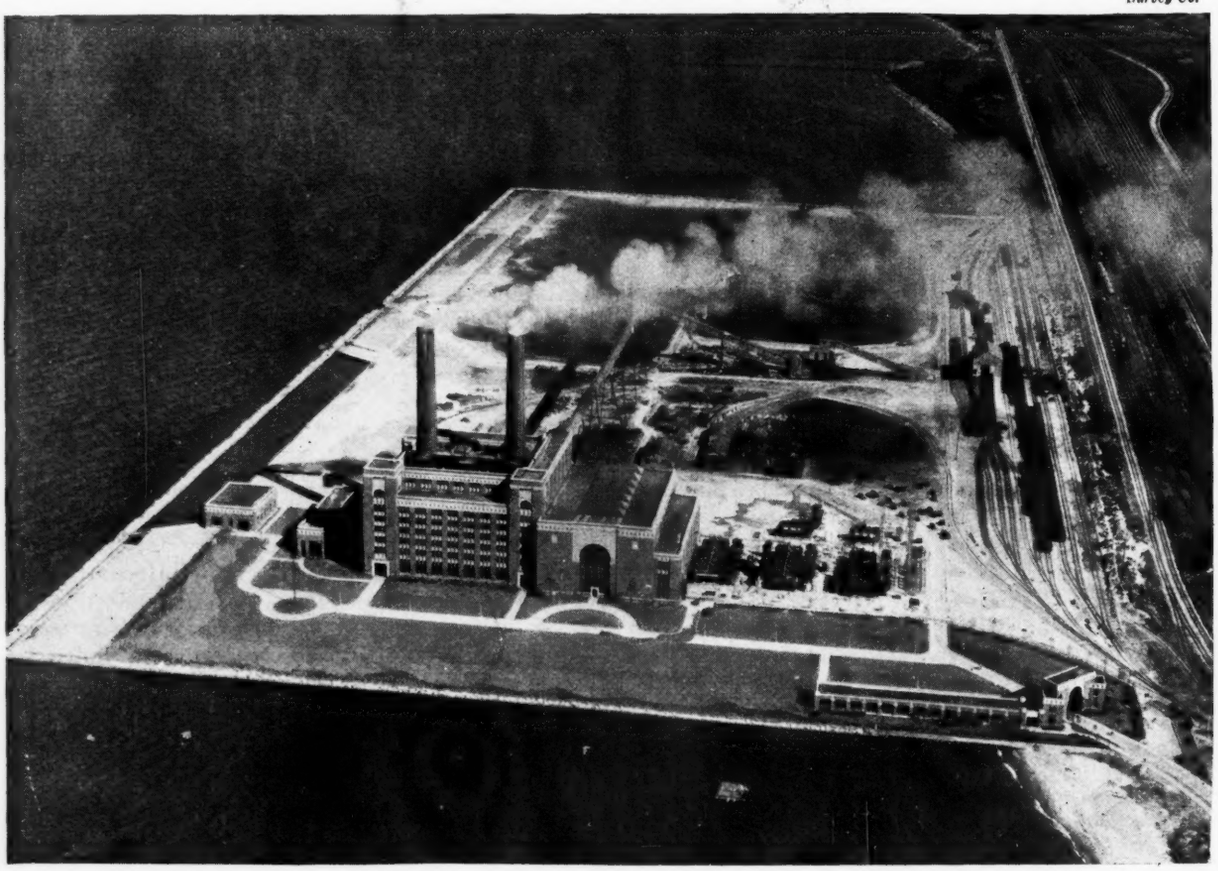


Governor and control equipment on high-pressure turbine

Advantages gained from the use of metal-clad outdoor switchgear are as follows: Maximum safety to the operating and maintenance personnel; minimum opportunity for a phase-to-phase short-circuit; and reduction in cost by eliminating the switch house and by providing a switching arrangement adapted to mass production in manufacture.

Aërial view of State Line Station and grounds

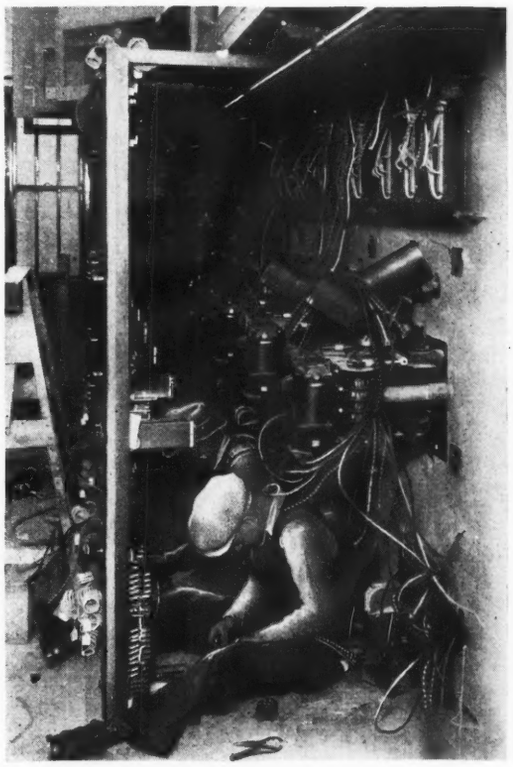
Chicago Aerial Survey Co.



INSPECTING AND TESTING

Procedure for Control Cable

By H. M. Friend
New York City



Workmen connecting cable to terminals at rear of switchboard

MANY of the larger public utility and construction companies have their own inspection departments to regularly test, at the place of manufacture, all control and other types of cable they purchase. The usual procedure is to make preliminary inspection of the single conductors after they are insulated but before the colored braids are applied. These conductors are immersed in water for at least 12 hr., after which the high-voltage test is made. The test voltage depends upon the thickness of the insulation, which, in turn, varies with the operating voltage of the cable. For a 30 per cent rubber-compound insulation $\frac{3}{64}$-in. thick, the most common thickness specified by the American Institute of Electrical Engineers for 600-volt service, the test voltage is 3,000 volts for 5 minutes.

The voltage test in water is the most satisfactory way to locate defects in the insulation. As the water is in contact with the entire outer surface of the insulation and is grounded to one side of the testing transformer, the voltage applied between the conductor and the water is most effective in locating defects.

If the insulation on a conductor fails on this or the insulation-resistance test, it can be successfully patched and retested. The specification of the American Institute of Electrical Engineers allows patching of the insulation, but requires that the electrical and mechanical strength of the repaired part shall be as strong and durable as the remainder of the insulation and that the outside diameter shall not exceed the specified value.

After the high-voltage test, the insulation resistance between the conductor and water is measured and is reduced to a basis of megohms per mile or per 1,000 ft. at 60 F. For a 30 per cent rubber compound with $\frac{3}{64}$-in. wall of insulation the minimum insulation resistance in megohms per 1,000 ft. as specified by the American Institute of Electrical Engineers is shown in the table.

Physical characteristics of an insulated conductor are checked by the inspector from samples cut from the coils under test. Maximum and minimum diameters over the insulation are measured with a micrometer, then the diameter of the copper is taken and from these measurements the average wall of insulation is calculated. The method of obtaining the average thickness of insulation is given in the specifications of the American Institute of Electrical Engineers as follows:

"The average thickness of insulation shall be taken as one-half the difference between the mean of the maximum and minimum diameters measured at any one point and the average diameter of the conductor measured at the same point.

"In the case of multiple-conductor cable, the measurements shall be made on the individual wires before being cabled. The average thickness of the insulation shall be not less than that specified in Table I." [The table referred to is part of A.I.E.E. specification No. 63.]

For physical measurements, the number of samples to be taken is specified by the A.I.E.E. as not less than 10 per cent of the number of coils of insulated wire under test when the lot consists of twenty or more coils or reels; and when the lot consists of less than twenty, at least one sample shall be taken.

As the wall of insulation may not be uniform, the maximum and minimum thickness of the wall should be measured at a given cross-section. The A.I.E.E. specification states: "The thickness of insulation at the thinnest part shall be not more than 10 per cent less than the specified thickness, but in no case shall such 10 per cent allowance exceed $\frac{1}{32}$ inch."

The diameter of individual copper strands is measured with a micrometer and the number of strands is counted. The tinning of the copper strands is carefully inspected, and if a test for the quality of tinning is required it is made in accordance with specification No. 60 of the American Institute of Electrical Engineers.

The quality of the rubber and the correct vulcanization are determined by pulling samples of the rubber insulation. To easily remove the insulation from the conductor, the sample should be immersed in mercury overnight. The rubber is then tested in accordance with specification No. 63 of the A.I.E.E., the thickness and

width of sample are accurately measured and the sample tested in a standard tensile-strength machine. The force in pounds to break the sample is read, and the pounds per square inch is computed. For a 30 per cent rubber compound the minimum allowable tensile strength is 1,000 lb. per square inch. Before testing, the sample is marked at two places two inches apart and the stretch to break it is measured. The minimum allowable stretch is 9 inches.

For a quicker test, that gives approximate results, a sample of the insulation on which are bench marks 2 in. apart is stretched by hand until the distance between these marks is 6 in., then the force is removed and the marks must return to within $2\frac{3}{8}$ in. within two minutes, for the insulation to satisfactorily pass the test. The sample is then stretched to rupture, which should not occur until the elongation is at least 9 in. between the marks.

The A.I.E.E. specification states that samples of insulation for chemical analysis may be taken at the option of the purchaser. As the cost of chemical analysis of rubber is quite high, most purchasers do not include this in their inspection of rubber-insulated cable. However, where the purchaser has a chemical laboratory in his own organization an analysis of the rubber is often made.

If the insulated conductor successfully passes the foregoing tests it is released for braiding. The individual colored braids are then applied in accordance with the color arrangement specified by the purchaser. A coating of white paraffin is usually applied to protect the braid from moisture. The single conductors are then cabled together, jute fillers being used if necessary to make the cable round.

The importance of control cable in the reliability of power-plant operation warrants engineers taking great precaution to eliminate every possible defect in the cable before its installation. Methods of inspection and testing control cables that are easily applied, are given in this article. In the Nov. 19 number of *Power* the structural features of control cable were considered

For two-conductor cable, the conductors are laid parallel to each other, and no filler is used. (This is known as twin cable.) A rubber-faced tape is then applied with an overlap to hold the conductors in place. The tape should be rubber faced on the outer side only, otherwise the braids on the conductors will be discolored. The outer covering, lead sheath, flameproof or weatherproof braid, is then applied and the cable is ready for final inspection.

As the individual conductors were given a preliminary voltage test in water, the final voltage test is mainly for the purpose of locating defects in the insulation caused by mechanical injury when passing through the factory. In this test it is not possible to obtain the thorough grounding of the entire outer surface of the insulation of each conductor, as was the case in the preliminary inspection in water. If the cable is lead-covered, the voltage test between conductors and sheath is of some value, but between conductors the wall of insulation is twice that on the individual conductors, while the surface of contact of the two conductors is considerably less than the entire surface of the insulation.

In the final voltage test of flameproof or weatherproof braided cable, the most satisfactory test is to apply a voltage between conductors of twice that used for the preliminary test. Double voltage is used on this test, as the insulation between two conductors is twice that on each conductor. The preliminary voltage test if used here would not be sufficiently high to show a defect. No test to ground is made, as the cable is not immersed in water.

For lead-covered cable, to test each conductor against the other conductors and sheath means as many tests as there are conductors. As this would require considerable time, a shorter method of testing is generally used.

For a two-, three- or a four-conductor cable with a lead sheath, two tests are required: On a two-conductor cable, No. 1 wire is connected to the lead sheath and test voltages applied between No. 2 wire and the sheath. In the second test, No. 2 wire is connected to the lead sheath and the test made between the sheath and No. 1 wire. When the cable has a braided covering the test voltage is applied between the two conductors only. The diagram shows the arrangement of the conductors in the cable.

In a three-conductor lead-covered cable, wires 1 and 2 are connected to one side of the test circuit and wire No. 3 and the sheath are connected to the other side. When making the second test No. 1 wire and the sheath are tested against No. 2 and 3 conductors. When the cable has a braid covering, No. 3 wire is tested against 1 and 2 in one test, and in the other test No. 1 wire is tested against 2 and 3.

When testing a four-conductor cable, wires 2 and 4 are connected to the sheath and tested against No. 1 and 3, then 1 and 3 are connected to the sheath and tested against 2 and 4. The same tests are made on a braid-covered cable, except there is no sheath to include in the test.

Five-conductor cables with a lead sheath require three tests. In one, wires 2 and 4 are connected to the sheath and tested against 3 and 5. Wires 3 and 5 are connected to the sheath and tested against 2 and 4 in a second test. For the third test, wires 2, 3, 4 and 5 are connected to the sheath and tested against No. 1. On a braid-covered cable tests are made on wire groupings used in the last two tests made on the lead-covered cable.

Seven-conductor cables with a lead sheath can be tested by three groupings of the conductors and the sheath. First, wires 2, 4 and 6 are connected to the sheath and voltage applied between them and wires 3, 5 and 7 as a group. In the second test, wires 3, 5 and 7 are connected to the sheath and the test made against 2, 4 and 6 as a group. Wires 2, 3, 4, 5, 6 and 7 are connected to the sheath in the third test and voltage applied between this group and wire No. 1. The last two tests are sufficient to check a seven-conductor cable with a braided covering, as there is no lead sheath to be considered. The same system can be worked out for any number of conductors.

MINIMUM INSULATION RESISTANCE SPECIFIED BY THE A.I.E.E.

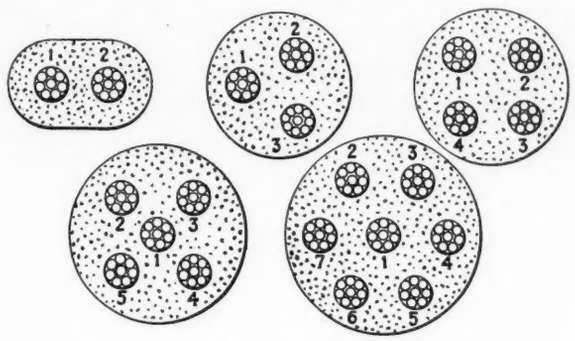
Size of Conductors No. B. & S	Thickness of Insulation, in. $\frac{3}{64}$ Megohms Resistance	$\frac{1}{8}$ Megohms Resistance
12	7,100	
9	5,225	
7		5,025
6		4,500
4		3,950
2		3,450

After the final voltage test, the insulation resistance between each conductor and all the other conductors and sheath (if any) is measured. The grouping of conductors as previously described for the voltage test may be used to reduce the number of readings. Where more than one conductor is tested against other conductors, the length of conductor in calculating insulation resistance must be taken as the sum of those in each group.

A continuity test should be made to make sure that there is no break in the conductors. This is determined by a bell test. All the conductors at one end of the cable are grounded and a bell and battery connected in series between each of the other ends of the conductors and ground.

The final inspection of all types of control cable includes a measurement of the outside diameter of the cable; a check of its construction to see that the required braids, tapes, thickness of lead sheath, manufacturer's marker, jute fillers, etc., are provided as specified, with special attention given to the colored braids.

The measurement of the outside diameter of the cable is quite important, and the maximum allowable value rather than the calculated value from the diameter of copper, thickness of insulation, tape, braids, etc., should



Arrangement of conductors in control cable

always be specified, thus giving the manufacturer some leeway. Where the specified thickness of insulation and construction of cable is provided, the minimum diameter of cable is the most desirable.

Some engineers specify that after installation a high-voltage test between conductors and to sheath shall be applied. Where the wall of insulation for leaded cable is $\frac{3}{64}$ in. thick this test can be 3,000 volts. But where the cable is covered with a weatherproof braid this voltage should be raised to 6,000 between conductors. The reason for the increase in voltage is that the test between conductors is actually across two thicknesses of insulation. A test to ground includes only one thickness of insulation, the outer covering of tape and weatherproof braid.

Whether or not this voltage test is required, a continuity test is usually made to insure that there is no break in the circuit and that the required splices are properly made. Both ends of each conductor are then marked with a permanent tag that gives the circuit number as appearing in the circuit and conduit list.

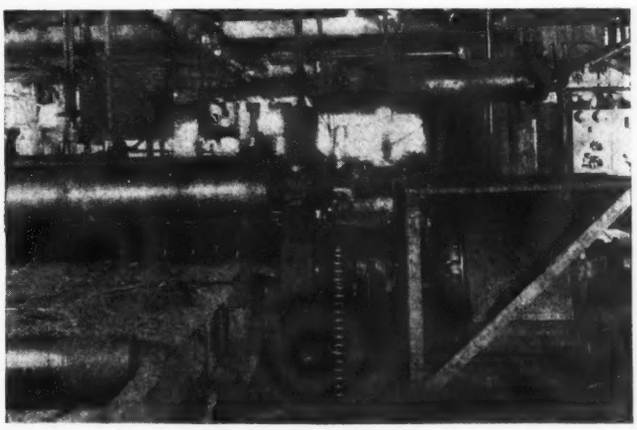
A comprehensive and accurate circuit and conduit list is an important feature of any control system. This list serves the purpose of a bill of material, as it gives the sizes, description and often the lengths of the various cables. After the control installation is completed the circuit and conduit list should be carefully checked against the actual installation and any corrections added that would be useful in the future.

Synchronous Motor Improves Power Plant Operation

By H. M. French
Industrial Engineering Dept.
General Electric Co.

THE Eastern Railway & Lumber Company, of Centralia, Wash., furnishes power for the city of Centralia, and it is necessary, therefore, to maintain close voltage regulation on the system. Substitution of a synchronous motor for an induction motor in the mill was found to improve conditions both with respect to voltage regulation and power factor.

This synchronous motor—rated 350 hp., 0.80 power factor, 2,200 volts, 3 phase, 60 cycles—replaced an induc-



Synchronous motor rated at 350 hp. replaced one of the induction type

tion motor direct connected to a 12x72-in. edger. Before the change, the plant was operating at a low power factor. A recent check, made after nine months of service, showed that the power factor at the power plant switchboard had been improved by about 10 per cent. It was also found that the voltage regulation had been materially benefited. The improvement in power factor enabled the mill to transmit current to the city over the size of copper cables in use to much better advantage, and the plant was also able to increase its lumber output because of more constant power supply.

December 10 Power

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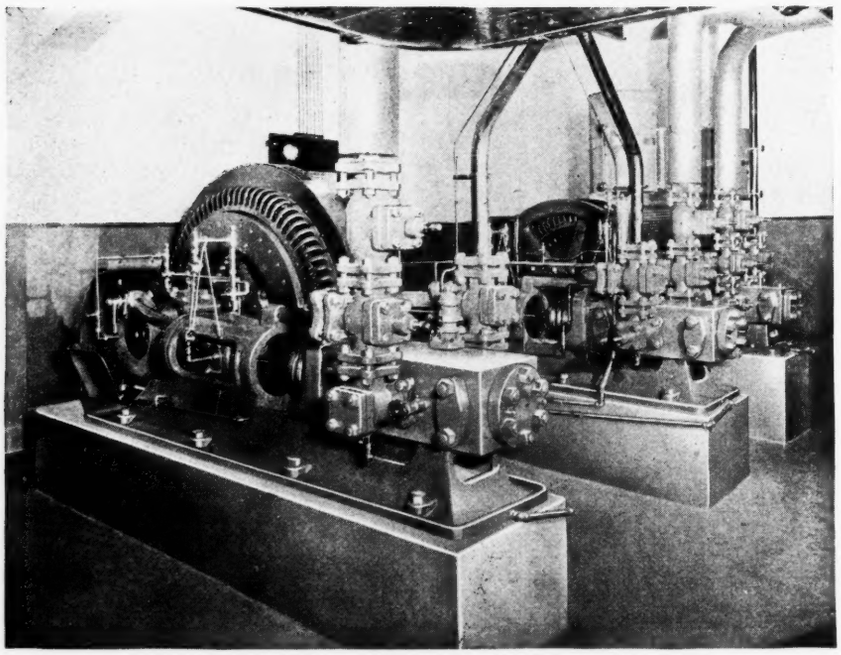
MANY READERS will not be privileged to attend the Annual A.S.M.E. Meeting, which is being held this week in New York. Among those who attend, many will not be able to listen to all the papers and discussions in which they are interested, owing to simultaneous sessions. For this reason *Power* will devote the greater part of next week's number to a report of the meeting.

The same number will also contain a report giving high spots and impressions of the Power Show.



Types of CO_2 Machines *for Refrigerating Plants*

By John Cassiday

THE wide application of carbon-dioxide refrigerating machines in hotels, office buildings, hospitals, and industrial plants, as well as on shipboard, increases the range of subjects with which the operating engineer must be familiar. Little, however, has been published concerning the CO_2 machine, which prompts me to outline the general principles of the system and mention the several types of compressors now in use.

The fact that the discharge pressure of the system may be over 1,000 lb. per square inch, and the suction pressure around 300 lb., has caused many engineers to feel that unusual difficulties may be expected. This, however, is not a true picture, for if the piping is made of the proper thickness, there is no more danger of leaks than with ammonia, and with the correctly designed compressor the unit bearing pressures are low. In fact the engineer who is familiar with ammonia refrigerating systems will be agreeably surprised at the simplicity of a CO_2 system and the freedom from operating difficulties.

The carbon-dioxide system, like the ammonia, is made up of an evaporator, a compressor and a condenser, each having minor accessories. It is the practice to place the evaporating coils and the condenser as close to the compressor as possible, to reduce the number of points that might give trouble under unusual conditions.

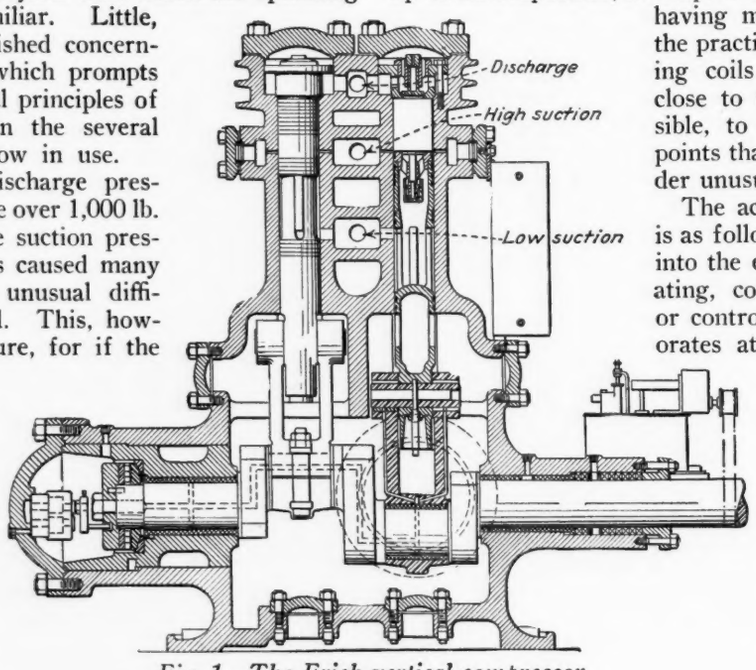


Fig. 1—The Frick vertical compressor

The action in the CO_2 system is as follows: Liquid is admitted into the evaporating, or refrigerating, coils by an "expansion," or control, valve. Here it evaporates at, say, 300 lb., and the resulting gas is withdrawn by the compressor and compressed to a higher pressure. It is then discharged into the condenser, where cold water causes it to condense, after which it returns to the receiver, to again enter the evaporating coil. As will

be seen, this is identical with the ammonia refrigerating cycle, but the pressures are far higher in the CO_2 systems. This is because liquid carbon dioxide has a higher vapor pressure than does ammonia.

As the purpose of the compressor is to raise the gas pressure above its vapor, or boiling, pressure at the temperature existing in the condenser, the pressure gage in the compressor unit indicates up to 1,000 lb. per square inch and more.

Such pressures, however, are not dangerous, if the equipment is properly designed. Even if a leak developed, no explosion would result, for carbon dioxide is inert and will not combine with air to form an explosive mixture.

The tendency of a gas to leak depends upon the pressure and upon the pressure of the space into which it may leak. As the suction pressure of an ammonia machine is, say, 30 lb. gage and the discharge around 150 lb., the leakage by the piston is far less than if CO_2 were being compressed in the same machine from a suction of 320 lb. to a discharge pressure of 1,000 lb. To reduce leakage, the piston of the CO_2 compressor must be made as small in diameter as possible, which calls for a cylinder with a long stroke and small bore. A long-stroke machine is likewise dictated by the requirement that the bearing pressures and the weight of the moving parts be kept as low as possible.

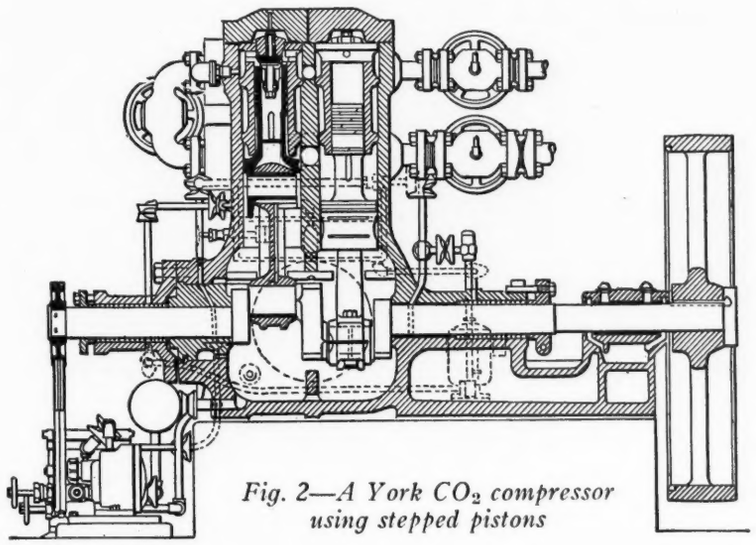


Fig. 2—A York CO_2 compressor using stepped pistons

Formerly such compressors were all horizontal, along the general lines of the machines shown at the head of page 884, with the piston rod passing through a stuffing box. This must be light enough to prevent leakage of the 1,000-lb. gas into the atmosphere. As the rod always warms up when the machine is operating, as soon as the compressor is shut down the engineer must lighten the gland to compensate for the shrinkage of the rod. The constant attention of the engineer is needed to adjust the stuffing box to the varying operating temperatures. When installations are of a size to warrant the employment of a refrigerating machine attendant the horizontal machine has important advantages.

A vertical inclosed compressor using a removable cylinder line is shown in Fig. 1. The piston is of the stepped type, with the suction gas entering the space formed by the two diameters. The gas passes up through a slot into the hollow piston to enter the cylinder space through a poppet valve in the center of the piston crown.

The lower portion of the piston carries the crosshead pin, so the side thrust is not imposed upon the wall of the compressing cylinder.

In Fig. 2 is shown a second design of compressor embodying an extremely long piston supported at the lower end by guides machined in the frame casting. This machine is arranged for dual compression, whereby after low-pressure gas has entered the cylinder through the valve in the piston crown high-pressure suction gas enters through a row of ports uncovered by the piston at the end of its suction stroke. Snap rings seal the piston against leakage into the crankcase; but the frame is designed to withstand the full cylinder pressure.

A vertical design in which a stuffing box is used is shown in Fig. 3. It will be noticed that a piston rod and crosshead are used, so that side thrust is not experienced by the piston. A long lantern and an appropriate number of rings make up the rod stuffing box. Any leaks from the cylinder pass into the lightly sealed box at the top of the frame. Consequently, no mixing of lubricating oil and carbon dioxide takes place in the crankcase.

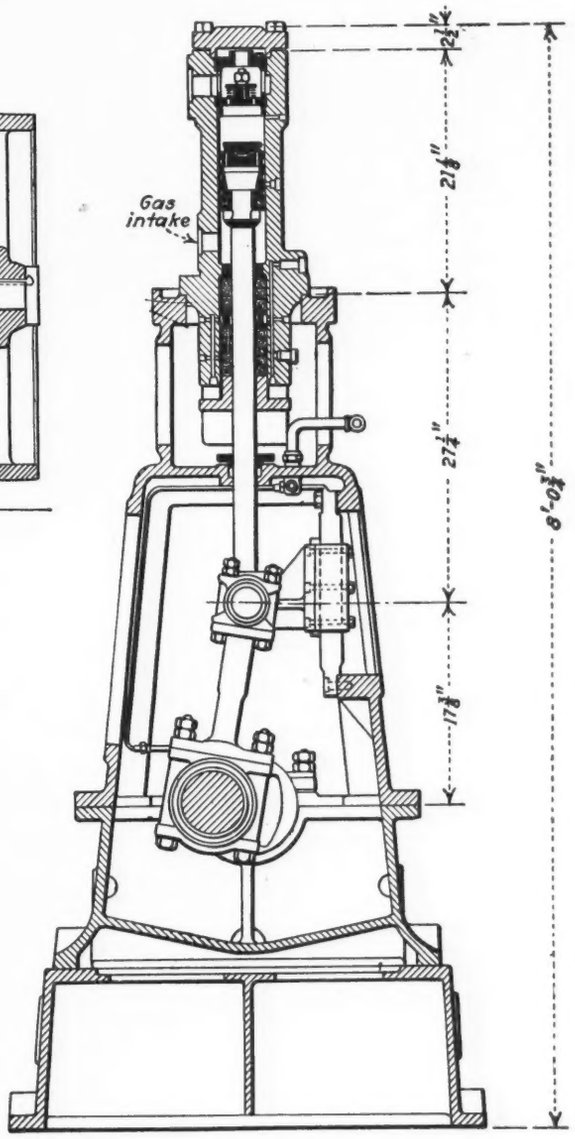
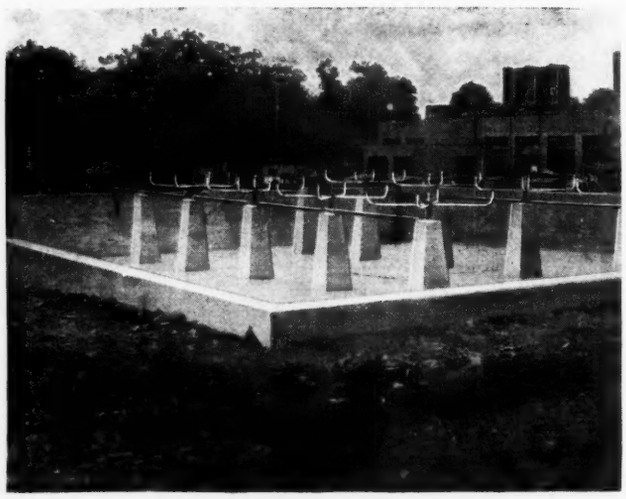


Fig. 3—A vertical three-cylinder Brunswick-Kroeschall compressor

COOLING TOWERS

for Diesel Plants



A popular type of spray pond

By L. A. PEASE
Assistant Director of Engineering, Fairbanks, Morse & Co.

IN ALMOST all Diesel installations some form of cooling tower or spray pond is necessary. If the water is pure, it is passed through the engine jacket and is then recooled. If it has scale-forming characteristics, a closed system should be used, in which rain water is recirculated and is cooled by rain water, which in turn is recooled by a tower or pond.

The equipments commonly used for reducing a water's temperature are: Cooling towers, natural-draft, open, atmospheric and forced-draft types; spray towers; and spray ponds.

These devices cool the water in two ways: First, through radiation and conduction by heating the surrounding air, and, second, by evaporation of a portion of the water. The first involves transfer of the sensible heat, and the second involves the transfer of latent heat. As the latent heat of vaporization is approximately 1,000 B.t.u. per pound for water, the evaporating of one pound will lower 100 lb. of water in which evaporation occurs almost 10 deg. F., or 50 lb. 20 deg.

In modern towers this evaporation is the factor used mostly in cooling the water. The rapidity with which evaporation takes place is determined by the temperature difference between the air and the water, the relative velocity of the air and water, and the relative humidity of the atmosphere and the wet-bulb temperature. A good tower will reduce the water temperature considerably below the dry-bulb temperature, when there is a considerable difference between the wet- and dry-bulb temperatures.

All cooling towers and spray ponds produce the cooling effect by moving finely divided particles of water against a moving current of air. With the spray pond the water surface consists only of the moving drops, while the towers have, in addition to these drops, large wet surfaces.

As the majority of Diesel plants use open atmospheric towers, this type only will be discussed. A general outline of the construction of an open atmospheric tower for engines of 560, 700 and 840 hp. is shown in the drawing. The towers are 12 ft. wide inside and 40, 50 and 60 ft. long, respectively. This tower is simple to construct and will give excellent service.

Towers may be made of wood or steel. A wood tower should be made of cypress, red spruce or California redwood, and should be designed to withstand a wind pressure of 30 lb. per square foot of exposed surface on the long side. Bolts, nuts, and washers should be of brass or galvanized iron.

The louvers should be No. 1 seasoned cypress, or equivalent, and placed at such an angle as to permit a minimum loss of water during heavy winds and also to allow sufficient movement of air through the tower during times of very low wind velocity. They may be placed only on the sides opposite the prevailing winds, or on all four sides.

The distributing troughs and decks should be constructed so that the water is finely divided and remains in this state throughout its entire fall. The detail of construction may vary considerably and still be efficient.

The entire tower is usually located in a reservoir, commonly of concrete, arranged to maintain a certain pondage, depending upon the design of the system.

It is well to have an apron around the tower, directly above the basin, as this will retain a large amount of water that has blown through the louvers.

It is impossible to give data on a tower suitable for all locations, for the capacity depends upon air temperature, the relative humidity and water circulation per horsepower per hour. These figures, of course, vary with the situation of plant, making it necessary to obtain from the tower builder a definite recommendation for each specific job, if one is to secure the most from the cooling equipment.

In cities where the underwriters will not permit wood construction, the tower can be all steel.

The function of a spray tower is the same as a cooling tower. The construction, however, is quite different. A spray tower is usually built up in square sections in capacities of 100 gal. per minute of water (although some are made several times as large), with louvers on all four sides and a system of spray nozzles located at the top center. Usually there are no platforms or dis-

tributors used. The nozzles spray the water in finely divided particles throughout the tower area and also over the upper surface of the wide louvers.

The spray nozzles used are simple in construction and non-clogging. Many kinds and sizes are made and guaranteed. Table I gives data on capacities of nozzles. Seven pounds is the standard pressure used.

TABLE I.—CAPACITY OF NOZZLES

Pipe Size, In.	Discharge Orifice, In.	Gallons per Min. at Nozzle Pressure 6 Lb.	7 Lb.	8 Lb.
1½	7/8	18	20	22
2	1	36.5	40	43
2½	1	65	71.5	78.5
3	1¼	96	111	123

If one tower is not adequate, two or more can be used. For large installations, it is well to have the tower maker give definite recommendations.

The construction of a spray tower is such as to permit it being placed at almost any convenient part of the plant grounds, or on the plant roof, just as long as there is a free circulation of air throughout it at all times. For example, in one case three 70-gal. per-minute towers have been installed on the roof of a plant where ground is not available. As each tower is self-contained and has a water sump at the bottom, it is necessary only to build a fraemwork suitable to hold it and make proper connection to the piping system.

Spray ponds are in common use for cooling of Diesel engine water and are quite satisfactory. They require more area than towers, but not much height. They may be constructed without louvers, or with louvers high enough so that loss from windage will be kept to a minimum. The usual construction calls for a concrete pit 1½ to 2½ ft. deep, with a screened cold well at one end, from which the cooling-water pump takes its suction. The walls are usually 8 to 12 in. thick and the bottom 5 to 6 in. thick.

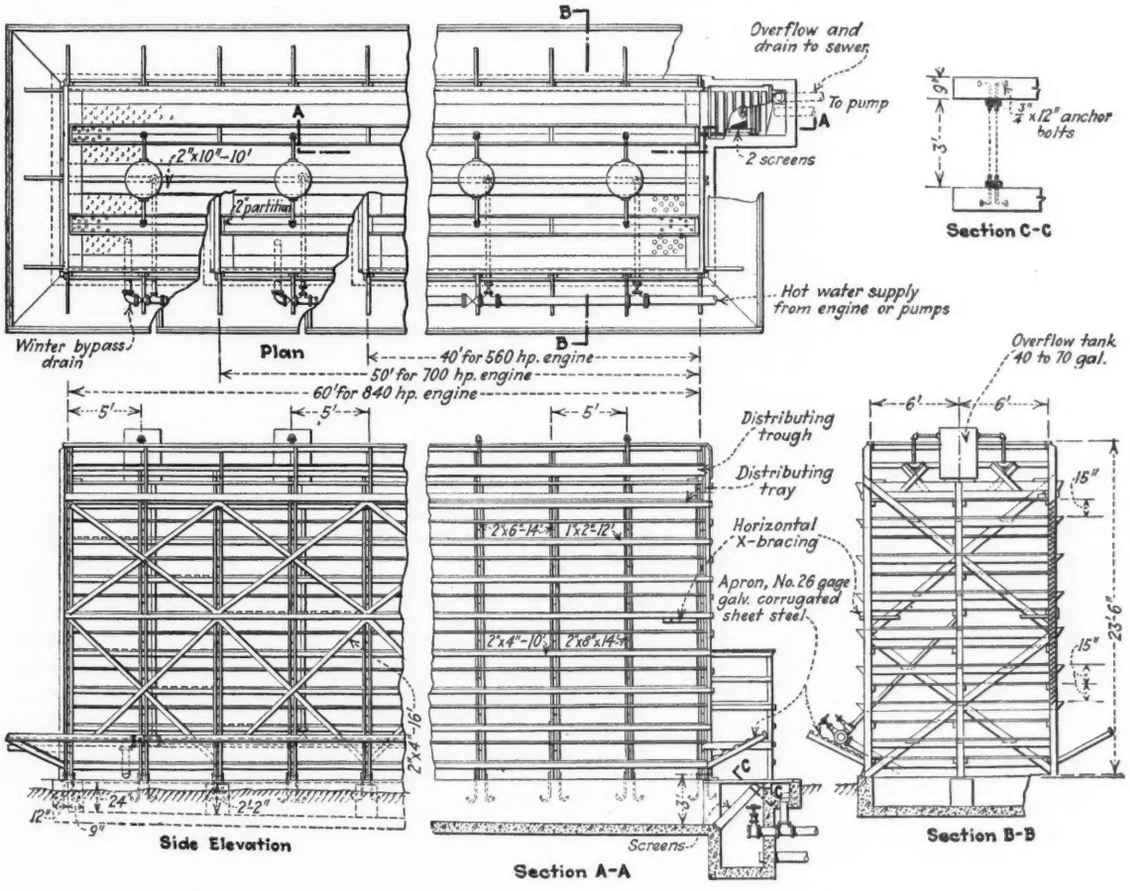
Nozzles are usually 1 to 7 to a cluster and are spaced 13 ft. apart and 14 ft. from the louvers. Pipe sizes are arranged so that friction loss is small.

In Table II are data as to capacity, area, number of nozzles and arrangement made by one manufacturer of

TABLE II—CAPACITY OF SPRAY PONDS

Capacity, Gal. per Min.	Nozzles Number	Size, In.	No. of Clusters	Nozzles per Cluster	Size of Basin Width, Ft.	Size of Basin Length, Ft
300	15	1½	3	5	28	54
350	15	1½	3	5	28	54
400	20	1½	4	5	28	67
450	20	1½	4	5	28	67
500	25	1½	5	5	28	80
600	30	1½	6	5	28	93
700	35	1½	7	5	28	106
800	40	1½	8	5	42	67
900	45	1½	9	5	42	80
1000	50	1½	10	5	42	80
1200	30	2	6	5	28	93
1400	35	2	7	5	28	106
1600	40	2	8	5	42	67
1800	45	2	9	5	42	80
2000	50	2	10	5	42	80

spray ponds. From this may be chosen cooling-pond equipment for engines requiring 300 to 2,000 gal. per minute, with either direct or indirect cooling systems. This table covers 1½-in. and 2-in. nozzles, and it is assumed that 7 lb. per square inch pressure is available at the nozzle. It is based on 120-deg. water from the engine in the case of direct cooling, and 116 deg. in the case of indirect—cooled to 100 deg. F. In choosing a pond, it is well to have an open space around it, so that prevailing wind may aid in evaporation, and, consequently, in cooling.



Diagrammatic layout of a commonly used atmospheric cooling tower

World Power Problems

Opening session of World Power Conference, Prince Chichibu presiding

Personal Impressions

By Kendall K. Hoyt

Special Staff Correspondent of Power

As THE World Power Conference in Tokio reaches a close, there is no question among the delegates as to the success of the meeting and of the practical advantage of future meetings in other world capitals to keep remote elements of the power industry in close contact. Although somewhat overshadowed in newspaper accounts by the more imposing World Engineering Congress with which it was jointly held, the power conference was, because of this, a more brilliant success. From the moment of landing at Yokohama, with the unusual sight of Fuji looming above the harbor, up through the closing ceremonies on Nov. 7, everything carried through under the most auspicious circumstances.

As for social activities, the two conferences so mingled that one was part of the other. So many of the delegates wore the badges of both meetings that it would have been impossible to separate them. When it came to technical matters, the power group was at a decided advantage. The schedule of the Engineering Congress was so crammed with all manner of material that time for exhaustive discussion was seldom available. The sectional meetings of the Power Conference were given a limited number of papers, which they were able to study in relative leisure.

Perhaps the most important part of the program is yet to come, with the tours and plant visits that will continue for some weeks after the closing of the formal sessions. These will be reported later. During the past two weeks most of the delegates have seen little of industrial Japan outside of Tokio and Yokohama. The side trips have been mainly of a scenic nature, including the temples and trees of Nikko and views of Fujiama from the picturesque Hakone hot springs district. This is the best time of year in Japan. The maple leaves are just turning, and the weather is mild, with but occasional rain. From now on, the parties are working south to ancient Kyoto, the former capital, and to the industrial regions about Osaka and Kobe, where plant inspections are among the high spots of the program. Large groups are booked for Formosa, Korea, China, and Manchuria, where, as well as having a most enjoyable time, they will observe with trained eyes and return to America in January with a real grasp of Oriental conditions.

Thus far the outstanding feature of the conference has been the extreme hospitality of the Japanese. It is customary to say nice things about one's hosts, but in this case something out of the ordinary has happened. Foreign residents in Tokio remark a bit enviously that the conference people have been shown more—including things that seldom are viewed by foreign visitors—in a few days than they have seen in years of residence. When it is remembered that Japan has been open to outsiders for only half a century and still is bound by old traditions to reticence on many matters, all this looms larger than is at once apparent. Nearly everything has been thrown open to the guests, from the royal palace grounds and the homes of wealthy Japanese to the government workshops, which usually are barred.

A word should be said about the social events, which have put technical matters in a very minor place. After all it is well enough recognized that the real business of a conference is done over the dinner tables and casual gatherings rather than in formal sessions. The past two weeks have seen a continual coming and going in frock coats and top hats, with hardly a breathing spell between times. All facilities have been furnished, including cars,

MS Discussed at TOKIO CONFERENCE

which were donated for the occasion, and free passes on the government railways for interurban use. It need not be told how the delicate setting of Japanese gardens, houses, and landscape have added to the enjoyment of the conference. To sum it up, everyone here agrees that the whole affair has been excellently well handled. Due acknowledgment should be gvien to Prince Chichibu, who has been an ideal patron; to Baron Koi Furuichi, president of the conference; to the Japanese government; and to the many individuals whose generous support made these things possible. As to the work of the American members, O. C. Merrill and his assistants have done much to further the success of the conference.

As for the technical sessions, one seldom expects much startling news out of papers prepared so far in advance. Nevertheless, nearly every branch of the power industry received some contribution in technique that will stand as a lasting contribution. How much more was gained through personal contacts is needless to stress. For engineers to exchange ideas with recognized authorities from all parts of the globe results in a broadening effect on the industry of which too much cannot be said in encouragement. At the instance of Dr. Stan. Spaeck, of the Czechoslovakian delegation, a resolution was offered advocating the creation of a world federation of engineers, which movement has received support in Europe.

High Spots of the Technical Sessions

Engineers from many nations exchange views on combustion—Steam generation—Diesel engines and water power

THE TECHNICAL SESSIONS *of the World Power Conference were divided into four sections, dealing with the national and international development of power resources, the rational unification and economical administrations of electric power development, power for use in transportation and better efficiency in power generation. The papers presented at this latter section included discussions on combustion, steam generation and storage, steam turbines and Diesel engines.*

IN THE discussion of steam generation and the storage of fuels, fourteen papers were presented. Speaking of pulverized coal, G. C. K. Blythe, Great Britain, said that nothing could be further from the truth than the oft-repeated statement that pulverized coal burns like gas or oil. In the case of gas or oil vapor, higher velocities mean greater speed of combustion, but for pulverized coal the length of time required for combustion remains approximately the same regardless of the velocity of injection.

Prof. R. K. Ramzin, of the Union of Soviet Republics, said that, under Russian conditions at least, the unit system of firing pulverized fuel was more economical than the centralized system.

R. Jackson, of Great Britain, in a paper on modern developments in pulverized-coal firing, confirmed the views of Mr. Blythe and Professor Ramzin favoring the unit system over the storage system for pulverized coal by mentioning the difficulties of drying and satisfactory separation in the latter system. In addition, he said that the unit system had lower capital cost, lower maintenance and operating costs and lower power consumption.

Discussing the use of pulverized fuel for small shell-type boilers and for metallurgical and chemical processes, H. W. Hollands and E. T. Lowndes, Great Britain, recommended, for such applications, gasifying the powdered coal separately in a primary chamber and then introducing only the gaseous products into the combustion zone.

Two papers dealt with air preheaters. C. A. Jacobson, of Sweden, spoke of the advantages of the regenerative type over the recuperative type, stressing chiefly the fact that corrosion of the heating element would not interrupt the operation of the regenerative preheater. Messrs. Lysholm and Edenholm, Sweden, presented results of tests on heat transmission over a wide range of gas velocities and with various types of flow.

The question of the best ratio of the heating surface subjected to radiant heat to the total heating surface of the boiler, for the greatest dollar economy, was discussed by Prof. T. Lindmark, Sweden. His final conclusions suggested that the most suitable boiler might consist of radiation surface alone, provided the air preheating, superheating and preheating of the feed water are high.

Steam generation and high pressures were discussed by F. H. Rosencrants, Great Britain, and Dr. X. Mayer, Germany. Mr. Rosencrants felt that higher steam temperatures would offer more economic gain than higher pressures as soon as materials of suitable resistance were available. Dr. Mayer referred to the general trend in Germany to increase pressure and temperature without preheating. Dr. Pauer felt that reheating is chiefly economical when the working pressure is above 1,500 lb. and that the economical pressure without reheating is about 600 lb.

Dr. W. Pauer, Germany, emphasized the need of smaller diameter boiler drums to save cost, and said that these should be combined with steam accumulators to meet the varying loads.

Dr. J. G. Ruths, Sweden, and three other contributors discussed the Ruths steam accumulator. According to J. Tobolla, Sweden, 415 Ruths plants are in operation or under construction in 27 countries.

The present status of the Emmet mercury vapor process of power generation, as exemplified by installations in Hartford, Conn., was revealed in a paper before

the Engineering Congress by W. L. R. Emmett, consulting engineer of the General Electric Company. The present installation involves an hourly vaporization, at 10,000-kw. load, of 1,150,000 lb. of mercury and 125,000 lb. of water. Mercury vapor is delivered at 880 deg. F. and 68 lb. pressure, exhausting at 28.5 in. vacuum into the mercury condenser, where steam at 270 lb. gage pressure is produced. The steam is superheated to a final temperature of 810 degrees.

Using the vapors in the most modern turbines and with the best existing arrangements this plant would generate a kilowatt-hour for 9,140 B.t.u. In future applications of this process, said Mr. Emmett, it is expected to use the mercury heating surface on the walls of the furnace. This will give a means of delivering more of the total heat of fuel to the mercury vapor and will also make it possible to dispense with the economizer and to use more air heating and a much greater application of regenerative feed heating.

Steam Turbine Trends

Two papers were presented on the general trend of steam turbine practice, one by E. L. Robinson, of the General Electric Company, and the other E. A. Kraft, of Germany. E. L. Robinson in his paper observed that the only factor of uncertainty that had to be explored in the course of the growth in turbine design during the past ten years was the cost of accomplishment and how far the refinements of design dictated by theoretical consideration would be warranted in the reduced cost of the finished product. In the practice of steam expansion, turbine design has advanced from two- or three-point extraction to as high as five-point extraction, where highly regenerative heat balance is desired.

Instead of single overload valves, multi-valve machines are now being required, resulting in a relatively flat load

Dinner for the International Executive Council of the World Power Conference

curve extending from 33 to 100 per cent load. With the trend toward high pressure, re-superheating has largely been resorted to, with a resulting development of large compound units. These units have advantages particularly adaptable to resuperheating.

E. A. Kraft's paper dealt with the general trend in the development of back-pressure and bleeder turbines, with particular reference to their design, construction, performances, and combinations with condensing turbines.

Two papers were presented regarding the double-rotation axial-flow turbines, one by O. A. Wiberg, and the other by M. T. Lindhagen and Alf Lysholm. The paper presented by Mr. Wiberg follows closely the article published in the Nov. 12 number of *Power,* while the other paper describes the suitability of the radial-flow turbine for higher temperatures and pressures.

The capacity limit of steam turbines was discussed in a paper by M. B. Muto, of Japan. According to Mr. Muto, the capacity of the direct-coupled turbine-generators has heretofore been a problem associated with the generator side only, but studies in connection with generator material and construction have changed this condition. Among the factors limiting the capacity of turbines he considers the maximum allowable stresses of the last row blades and the effect of high pressures and high temperatures on maximum turbine capacity.

The effect of high pressures and temperatures on power generation was further considered in three papers by O. A. Wiberg, G. A. Orrok, and R. W. Bailey, respectively. Mr. Orrok in his paper placed the present limit of pressure at 3,200 lb., and of temperature at 900 deg. F. He found the cost of installation for high-pressure work has been shown to be only 5 to 6 per cent in excess of standard construction costs, although a number of authorities have found no excess whatever.

With the rise in pressures and temperatures, the thermal economy of plants has increased from 18,000 B.t.u. per kilowatt in 1922 to the low figure of 12,500 B.t.u. per kilowatt, attained by one station, and to 14,000 B.t.u. per kilowatt, attained by six other stations.

The paper by R. W. Bailey described experiments on the creep characteristics of materials, not only under simple tension, but also under combined stresses of tension and torsion. He found that, by plotting the creep rate to logarithmic scale and interpolating it, there is no such true creep limit as had been supposed, but that a very small creep always exists.

Mr. Wiberg in his paper presented some charts that indicate the limits of pressure and temperature for seven types of carbon and alloy steels and also on the same chart the thermal efficiencies that may be expected of a plant using these various materials. Such charts were made up for plants of 50,000-kw. capacity using both the regenerative and the resuperheating cycles.

An abstract of this paper together with the curves will be published in a future issue of *Power.*

Diesel Engine Developments

In the session dealing with Diesel engines, three papers were presented, one by Dr. A. Naegel, Germany; one by Dr. M. Ino, Japan; and the third by Dr. G. Hamabe, Japan.

The first two of these papers dealt with the development and future of the Diesel engine in Germany and Japan, respectively. Both authors agreed that in these countries the double-acting two-stroke-cycle engine should be used exclusively for outputs of more than 8,000 b.hp. and that for smaller sized engines the single-acting four-stroke-cycle employing supercharging should be used. Dr. Ino stressed the great increase in the use of Diesel engines on ships.

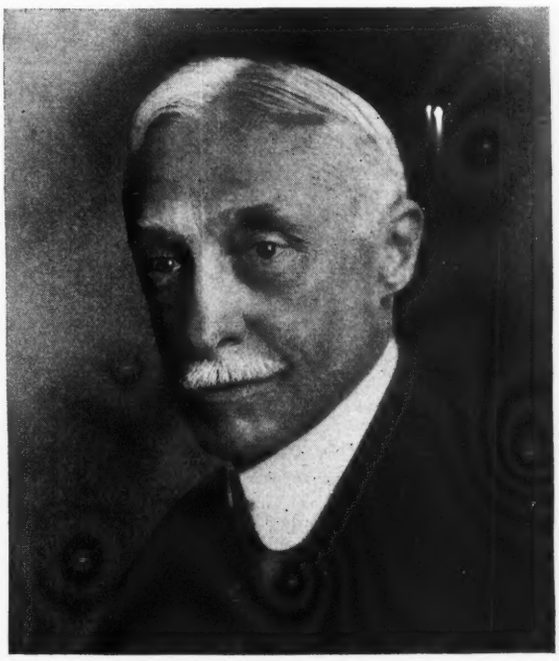
The paper by Dr. Hamabe dealt with the effect of the exhaust-gas turbine applied to the Diesel engine for supercharging.

In the marine propulsion session two papers were presented, one by T. Tajima, and the other by T. Kawanura, both comparing the use of steam engine and Diesel engine as prime movers for motorships. In both

papers a study of the operating costs and economics of the question involved has been made on sister ships, one using a steam engine prime mover and the other a Diesel engine.

At the World Engineering Congress L. H. Morrison in a paper on American development of the Diesel engine, reviewed the early history, up to 1912, of Diesel building.

Due to the cheapness of oil and to the large territorial extent of the United States, more Diesels are installed there yearly than in any other country. These are all below 4,000 hp., and the average engine capacity is approximately 200 hp., with a yearly total of new installations of 440,000 hp. The majority of Diesels so installed are of the mechanical-injection type; the two-stroke-cycle Diesel is sold in the greatest number, but the rate of increase of the four-stroke-cycle mechanical injection engine is the greater. A session of the congress was devoted to the discussion of the joint operation of hydraulic and steam power plants. Three Japanese authors presented papers dealing with the subject, two of them attacking the problem from a mathematical viewpoint, while the third dealt with the subject descriptively. At the World Engineering Congress this subject was discussed by George A. Orrok.



Elmer A. Sperry, Chairman, American Committee

The economics of water vs. steam power is, so long as the coal supply is assumed to be practically inexhaustible, purely a question of the cost of power production and distribution from its source to the market where power is used. In regard to water power sites, the fixed cost may vary from as low as $60 per kilowatt with transmission to over $400 per kilowatt. Indeed, many investigated sites figure higher than $600 per kilowatt. Transmission lines may cost as low as $7,000 per mile or as high as $100,000. From this widespread field it is evident that, to be of any value, any calculation must be put in such a form that upon substituting two or more variables, we may find the cost per kilowatt-hour delivered at the market. These variables are load factor and the sum of fixed operating costs.

From the average of many cases, the operating costs amount to about $2.60 per kilowatt per year, while the transmission operating charge, including the substation at the receiving end, may be taken as $2 per delivered kilowatt of demand per year.

However, when the cost of steam power is evaluated, another very different set of conditions obtains. The lowest cost of which Mr. Orrok has record for a central station built since 1890 is $50 per kilowatt of capacity, while others have cost over $250 per kilowatt. The average cost has been about $100 per kilowatt.

It seems well to assume fixed charges on the steam plant at 15 per cent, or $15 per kilowatt per year. Labor, maintenance and supplies may be taken as 0.15c. per kilowatt-hour. The final factor, of course, is the cost of coal.

It may be said that, given a market of a certain type, steam plant costs show smaller variations than water plant costs. A dry year may increase the kilowatt-hour cost of water-generated current 100 per cent, while a 100 per cent increase in coal cost, the only real variable with steam-generated power, would add at best only 30 per cent to the cost of current.

Steam plants are self-sufficient. There are many systems, operating without hydro-electric auxiliaries, giving continuous electric service at reasonable cost. Hydro-electric auxiliaries may cheapen the cost, but cannot improve the service. Hydro-electric systems, on the other hand, are not usually sufficient in themselves and must use an auxiliary steam supply, for four reasons: (1) To give best system economy; (2) For stand-by purposes (failure of transmission); (3) For meeting the seasonal water deficiency; (4) For meeting the dry year water deficiency.

The hydro-electric company is faced with the necessity of restricting its sales in the dry year output, or it must purchase or generate by fuel sufficient kilowatt-hours to meet peaks and the yearly system demand for power.

Power Plant Electrical Equipment

Progress in the design and operation of electrical equipment was covered in three papers presented at the World Engineering Congress. F. D. Newbury in a paper "American Power Station Electrical Equipment" reviewed the present design trend.

Since 1912 the current generated in public plants has increased 350 per cent, and during the last five years the rate of increase has been double that of the previous 10 years. The rapidity with which American systems are growing and the size single systems have now attained explains many of the technical developments that are typically American: for example, the use of a single generating unit of 100,000 to 200,000 kw.; synchronous condensers and frequency converters of 50,000 kva.; transformer banks of 100,000 kva.; the extensive use of transformer tap-changing equipment to facilitate interchange of power between stations and between systems; and the rugged construction of oil circuit breakers.

In the application of large generating units the currents to be handled at usual generator voltages become so large that it is advisable to consider means for reducing the cost of switching equipment. The obvious remedy is to increase the generator voltage, and this has been done in several instances. Generator voltages of 16,000 and 18,000 have been employed in apparatus on the Southern California Edison system for a number of years. Recently voltages of 22,000 and 23,000 have been used in a number of turbine-generators of 60,000 kw. and larger. Generator voltages of 33,000 are possible without going beyond existing knowledge and safety.

Probably the most important development affecting operating conditions has been the general adoption of the closed-circuit cooling system. The outstanding advantage of this system is the elimination of dirt from the generator. Some operating engineers consider this one factor so important that they ascribe the major part of the improvement in generator reliability to the closed-circuit cooling system.

Higher efficiencies have been made possible by the use of low-loss, high-silicon steel (4 per cent nominal silicon content), reduction in armature I^2R loss, reduction in stray-load loss, and some reduction in windage loss as a result of better fan design and reduction in air friction. The most important source of reduction in loss has been the use of high-silicon steel.

Remote Control of Power Plants

Probably the most important developments in switching and power-control equipment during this period are in the field of equipment for unattended stations, which has been developed to cover a wide variety of functions and conditions.

The present status of remote control and supervision of power plants in the United States was presented in a paper by C. Richtenberg and Ferdenand Zogbaum.

In the paper, a general description of supervisory control and telemetering systems developed in the United States is given. The description traces this equipment from early days in 1898, when the first system operator's equipment was installed in New York City, to present-day installations. The authors have considered the most important developments, but have not included those systems not in general use.

The paper describes the following supervisory systems, step by step: selector, distributor, code visual, synchronous relay, synchronous selector, high-frequency carrier current, moderate-frequency carrier current, and audible.

The following types of telemetering equipment are outlined: induction, rheostatic, position-impulse, rectified-current, and audio-frequency.

Operating turbine-generators on a total temperature basis is an idea that has for some time occupied an active place in the minds of many operating and designing engineers, and was discussed in a paper by P. Torchio, W. J. Foster and F. D. Newbury.

In placing an operating rating on the total temperature, due consideration should be given to all factors affecting reliability and maintenance, so that when correctly established, the rating will represent the maximum output that can be taken under the existing operating conditions without jeopardizing reliability or unduly increasing maintenance cost. Such a rating can only be established on the basis of judgment and experience.

In the application of the total-temperature basis of loading, it is of fundamental importance that stator temperature measurements represent accurately and consistently the temperature status during operation, and that the order of the difference between the measurable temperature and the actual temperature of the copper winding be known.

In dealing with the total temperature it is the general practice to be conservative. Ninety degrees Centigrade, as measured by embedded detectors between coil sides, has been used in a number of cases as being conservative and consistent with long life of the insulation.

Among the papers of general engineering interest presented at the World Engineering Congress were: "Industrial Progress Made Through Research and Its Economic Importance," by W. R. Whitney, and "Recognition of the Engineer and American Engineering Societies," by E. A. Sperry.

American Engineering Societies

Mr. Sperry observed that the engineer has not always received the recognition now accorded him, and his struggle to attain this recognition has been greater than is usually realized. Even in modern times there remain many adherents to the tradition that to apply scientific knowledge to practical uses definitely degrades science.

We must look to engineering as one of the great universal forces that is to draw men of all nationalities into a closer bond of friendship and unity. As one contemplates this single fact, its great significance is at once manifest. This is one of the reasons why such an occasion as the World Engineering Congress provides a vehicle for bringing about closer international understanding among engineers, international co-operation and international professional class-consciousness.

The fundamental objects of American professional engineering societies are the advancement of the theory and practice of engineering and of the allied arts and sciences, and the maintenance of a high professional standing among their members. These objects are obtained principally by four methods: (1) meetings at which papers and reports upon developments in the various fields of engineering are presented and discussed; (2) publications that contain reports of these meetings, together with other data of interest to engineers; (3) the work of numerous administrative and technical committees that have jurisdiction over the principal activities of the society; (4) local organizations of members that hold frequent meetings in the principal centers of engineering and industrial interest, including student branches in the principal educational institutions in which instruction is given in engineering subjects. There are several hundred of these student branches of the four larger societies alone.

So the engineering societies provide opportunity for, and encourage, comradship, the interchange of ideas, the advance of ideals, the cultivation of the spirit of co-operation, and the inspiration that gives vision and incentive for new efforts and greater achievements.

Of more interest to engineers of other countries was the paper by F. R. Low and D. S. Jacobus concerning "The Rules for Construction of Boilers and Pressure Vessels and For Their Care in Service."

The Boiler Code Committee of the American Society of Mechanical Engineers was appointed Sept. 15, 1911, to prepare rules for the construction of steam boilers and other pressure vessels and for their care in service. The first section of the code, which was accepted for publication by the society on Feb. 13, 1915, embodied rules for the construction of stationary power boilers.

The primary object of the rules was to secure safe boilers. This code, establishing as it did a standard for safe boilers, discouraged the installation of inferior types even where their use was permitted. It also furnished to those charged with the administration of supervisory laws a specification of what should be required in the interest of public safety, conducive of uniformity in the practice of the various states and municipal agencies.

The eight codes that have been prepared by the Boiler Code Committee and published by the A.S.M.E. have been adopted by eighteen states, sixteen municipalities, the District of Columbia, Hawaiian Islands and the Panama Canal Zone.

Task and Bonus Wage System Helpful in Power Plants

By WALTER N. POLAKOV*
Consulting Engineer, New York City

PRISON treadmills are repugnant, because of their aimlessness. Running a race is an exciting sport, because of its aim and incidental exhibition of skill. The offer of a prize adds stimulation.

Working for a day wage is similarly different from working on task work with bonus. In the first case men try to comply with minimum requirements. In the second they excel their own past records. Task clearly defined provides the aim. To reach it skill must be acquired and exercised. Therefore, no task work shall be assigned without competent training given.

The bonus is the reward to those who learn. Incidentally, every dollar bonus paid means several dollars reward to the company for training given.

For instance, a fireman burns in the usual manner a ton of coal an hour. After the training he increases his evaporative ratio from 7 to 10 per lb. of coal. For the same output he now burns 1,400 lb. per hour; and he saves per shift 4,800 lb. of coal. He saves to the company more than double his wages. His bonus is his share of his savings.

A watch engineer or switchboard operator by carelessly distributing a 10,000-kw. load between several turbines consumes 21 lb. of steam per kw. After training, and with other necessary assistance, he distributes the load so as to consume, on the average, 20 lb. of steam per kw.-hr. He saves 80,000 lb. of steam per shift for the company, valued at about $30, which is perhaps four times his daily wage. His bonus is part of that saving.

Four untrained coal wheelers stock the coal on the boiler room floor. With training and proper rest intervals, and with standardized equipment, three men do the job, saving one-third of their daily wage. Part of this saving is their bonus.

Tasks may be set for quality of work, as in the first two cases, or for quantity of work, as in the last case. The use of brains is more profitable than just the use of muscles. A large manufacturing concern placed a billboard in the factory yard with this sign. "The woodpecker is using the outside of his head to earn his living—we want you to use the inside of yours."

Task work with bonus makes for the use of brains.

TASK WORK WITH BONUS

OBJECT—The task work with bonus, or two-rate wage, has the following objects in view:

1. It provides means and facilities for securing and developing additional skill.

2. It offers extra compensation for the exercise of additional skill which is over and above the guaranteed day wage.

3. The amount of bonus is a definite amount from the saving made. It is measured and weighed by accurate instruments, not by personal judgment.

4. It reduces unnecessary work and strain.

5. It provides interest in work, as accomplishments are recorded and the reward is paid.

TASK—The task is determined in every case by competent men, on the basis of many tests, under actual operating conditions. These tests take into account conditions beyond the control of the operatives.

Example: The task of 85 per cent boiler and furnace efficiency was established for the operation of a multi-drum water-tube boiler, fired with oil, steam atomized.

Task for Firemen: Thirty tests were made, which determined exactly the furnace draft in uptake, the speed of the oil pumps, and other operating conditions for any load between 90 and 190 per cent of the rating of the boilers. Eighty-five and one-half per cent efficiency was obtained under standard conditions in every instance. A summary of these tests is represented on the diagram, Fig. 1. To demonstrate that the task will be missed and the bonus lost if the draft in the uptake and furnace and the feeding of the oil are not in accordance with instructions, tests (shown in shaded areas) were run. With the draft purposely improperly adjusted, the efficiency resulting was 81, 82 and 82.5 per cent.

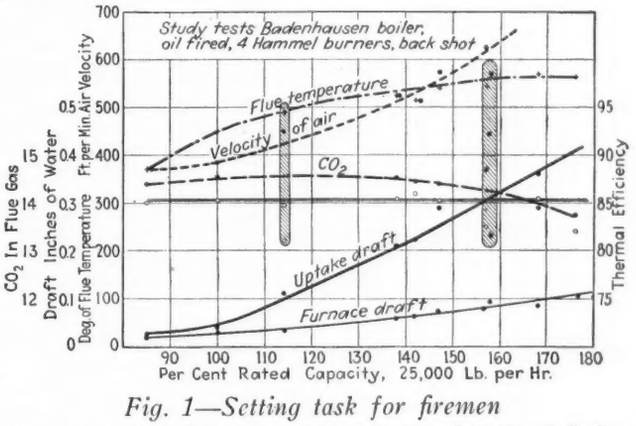

Study tests Badenhausen boiler, oil fired, 4 Hammel burners, back shot
Flue temperature
Velocity of air
CO2
Uptake draft
Furnace draft
CO2 In Flue Gas
Draft Inches of Water
Deg. of Flue Temperature
Ft. per Min. Air Velocity
Thermal Efficiency
Per Cent Rated Capacity, 25,000 Lb. per Hr.

Fig. 1—Setting task for firemen

Ten evaporative tests were conducted on a battery of Badenhausen boilers, oil fired, each with four Hammel burners placed for backshot. Readings for furnace draft, uptake draft, velocity of air, flue temperature, and per cent of CO_2 in the flue gas were recorded, and certain relations between air flow and steam flow were observed.

When firing was done according to the conditions prescribed, as in tests 1, 2, 4, 5, 6, and 9, the net efficiency is 85.5 per cent. When these conditions were neglected, and draft was not adjusted according to established relations to the load, as was done in tests 3, 7, 8, and 10, the average efficiency was below 82 per cent.

The task was set, therefore, as 85 per cent efficiency, and the instructions for firing cover the relations as established during the studies, which are necessary and sufficient for securing the task efficiency.

The above chart represents the summary of these observations. Shaded areas cover the readings during the tests conducted to show the ill effect of deviation from instructions.

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DEPT._____ DATE_____

NAME_____

YOUR PAY FOR THIS DAY IS AS FOLLOWS

DAY WORK_____

BONUS_____

TOTAL PAY $

PAY SLIP

Fig. 2—Sample pay slip for task work with bonus wage system

Task for Watch Engineers: Numerous tests were run on the steam turbines and steam engines to determine the minimum steam consumption per kilowatt-hour at different loads. The table of distribution of load between the units for different loads and corresponding steam consumption was worked out. A saving up to 5 lb. per kilowatt-hour is possible in extreme cases.

Task for Coal Passers: The task for a coal wheeler was set to deliver from the coal bunker to the floor and weigh and record 65,000 lb. of coal in 8 hours, against the previous standard of 45,000 lb. of coal in 12 hours. The detailed instruction card is shown.

Task for Unloading Gondola Coal Cars: For unloading coal from gondola cars on the trestle, and feeding it into the coal crusher, numerous studies and observations were made, and the task established as set forth in the instruction card, allowing one-half hour for unloading into crusher 10 tons of coal from the car.

BONUS—The task is calculated by the power plant record man every morning for the preceding day. For those employees whose records are equal or better than the task set, he prepares the bonus slip, entering on it date when the bonus was earned, the name of individual who earned the bonus, the symbol of the job, and the amount of bonus earned. These bonus slips are then placed in the proper slots, together with the time cards of the employees, to be picked up by them when they next report for duty.

He then prepares the summary of the bonus earned.

TASK FOR ENGINEERS AND SWITCHBOARD OPERATORS

The following steam consumption per kw.-hr. for various loads actually carried represents the maximum allowed. Bonus is paid if the reading of total of steam-flow meters when divided by the total reading of kilowatt-hour meter for the eight-hour shift gives the ratio less or equal to values given below:

1000 Kw.-Hr. Per 8 Hr.	Net Steam Used By Generators, Lb.	Task Steam Use Permissible, Including Auxiliaries, Etc.
10	18	23.5
11	17.6	22.8
12	17.3	22.0
13	17.3	21.2
14	17.3	20.3
15	17.1	19.6
16	16.7	19.2
17	16.8	19.2
19	17.7	19.9
20	18.0	20.2
21	18.5	20.2
22	18.9	20.2
23	19.0	20.2
24	19.0	20.2
25	19.2	20.2
26	19.4	20.3
27	19.6	20.6
28	19.7	20.7
29	19.8	20.8
30	19.8	20.8
31	19.7	20.7
32	19.4	20.5

attaches it to the payroll, and forwards it at the end of the week to the payroll department.

The payroll department includes in the pay envelope the total of the bonus earned or allowed during the preceding week.

Firemen's Bonus: Firemen working in a gang in the boiler house:

(a) Receive a bonus of $1 each for every 8 hours worked when the record of performance indicates that the efficiency of 85 per cent plus was maintained, and the steam pressure at no time during these 8 hours was below 225 lb. per sq.in. This applies to every shift, the record of each being entered separately.

(b) Firemen receive their bonus of $1 each for 8.3 hours when during that period the equivalent evapora-

MONTH | DAY | 19 YEAR

I HAVE INVESTIGATED AND REPORT BELOW THE CAUSE OF LOST BONUS

DEPT.

DISTR.

BY_____ ON JOB_____

CONDITION _____

RESPONSIBILITY IS ALLOCATED TO _____

REMEDY ATTENDED TO BY ME _____
SUGGESTED FOR APPROVAL

SIGNED

Fig. 3—Slip that is used for recording the cause of loss of bonus

tion per pound of coal burned was 10 lb. or more, which is approximately equivalent to 72 per cent efficiency, but as coal analysis could not be promptly obtained, the task is based on equivalent evaporation, and not on actual efficiency.

Bonus for the Operating Engineer: The bonus for the operating engineer is $1.50 per shift when the actual steam consumption per kilowatt-hour generated is equal or less than that indicated in the table for the total output during the shift.

Bonus for Coal Passers and Car Unloaders: The coal passers and car unloaders receive a bonus of 1c. per ton of coal unloaded or wheeled within the time specified by the task.

BONUS ALLOWED—A bonus is allowed whenever conditions beyond the control of the task worker prevent living up to the task. The report of every failure to live up to the task is to be made to the chief operating engineer or the watch engineer or the power record man, to claim the bonus allowed.

Bonus is allowed to firemen when the instruments indicating steam flow or draft are out of order, thus misguiding them, or there is any serious disarrangement of the equipment which was not properly and timely repaired. In such instances, upon inspection of the conditions, the chief engineer can allow the bonus.

Bonus is allowed to the watch engineers or switchboard operators in case the proper distribution of steam was impossible on account of units which should be thrown into service being unavailable because of being under repair, or by orders of chief engineer or maintenance man.

GENERAL INSTRUCTION CARD

Sheet No. 1.....District.....Department....

Description of operation: Passing coal from coal bin to front of boilers in 400 lb. wheelbarrow on concrete floor.

Operation Symbol: Year 13 Month 10 Day 13 Signed W.N.P. Checked

To be started	To be completed
6:42 a.m.	3:00 p.m.
2:42 p.m.	11:00 p.m.
10:42 p.m.	7:00 a.m.

Item	Detailed Instructions	Unit Time Min.	Time Allowed Hr.	Time Allowed Min.
1	Get shovel, long handle, 21.5 lb. capacity....			
2	Get wheelbarrow, 400 lb. capacity.....			
3	Check the scales, get the report sheet and pencil.....	4.00		
4	Open the door of your coal bin.....	2.00		
5	Place board to stock coal for next fireman....	0.18		
6	Shovel coal in wheelbarrow.....	1.25		
7	Lift wheelbarrow on scale.....	0.12		
8	Weigh by dropping or adding coal.....	0.33		
9	Wheel to front of boiler.....	0.16		
10	Dump and lift wheelbarrow.....	0.10		
11	Wheel back to bin.....	0.18		
12	Total time per wheelbarrow, with 20% for incidents.....	2.55		45
13	After 15 wheelbarrows delivered, rest sitting..	10.00		55
14	Pass 10 wheelbarrows per above detail instruction.....	25.5	1	20
15	Rest sitting.....	10.0	1	30
16	Pass 8 wheelbarrows as per above instruction.	20.0	1	40
17	Rest sitting.....	10.0	1	50
18	Pass 8 wheelbarrows as per above instruction.	20.0	2	10
19	Continue above operations until enough coal is passed.....	Same Allowance		
20	Sweep floor, get tools in shape, lock bin door..	10.0		
21	Return the key of the bin and report to office.	10.0		

Task is accomplished when within 8.3 hrs. all coal needed is passed without delays for firemen's work and instructions observed.
Bonus is paid over and above day rate 1 cent per 1000 lb. of coal passed during the shift if accuracy reports is within 2% of railroad weight.
The above work completed as described above. Signed.....

Bonus is allowed to coal passers in cases when proper equipment is out of repair, or the coal is delivered in a frozen condition.

Other cases of bonus paid and bonus allowed are described in instructions for work of the maintenance man, the power record man, and the power and steam dispatcher. In case the bonus is allowed, the bonus slip is prepared as usual, but a rubber stamp "allowed" is placed on the face of it.

BONUS LOST—Whenever the task as specified has not been lived up to, and no excuse on the basis of conditions beyond the task worker's control is considered valid by the chief operating engineer, the bonus will be lost and not paid. The power plant record man, or power house clerk, upon ascertaining from the chief operating engineer that no bonus shall be allowed in the case, will prepare the slip called "cause of lost bonus," in which he will indicate the date and the name of the task worker, and write fully and concisely the reason why the task was missed and the bonus lost, as can be found from a study of the instrument records and other evidences or testimonies.

The task worker who receives within one week the second slip of "cause of lost bonus" shall apply personally to the chief operating engineer to give his own explanations, and request additional training or facilities, as the case may be. The failure to do so will be considered neglect of duty.

Sample Instruction—Emptying Coal Cars Into Coal Crusher, Task with Bonus

Application

Coal cars of gondola type containing 20 tons or more, when unloaded into crusher.

Task

(*a*) Two men in car and one operating crusher—.03 hr. per ton.
(*b*) One man in car and one man at crusher—.05 hr. per ton.

Conditions

1. Not more than four cars may be on the siding at once.
2. When three operators are used, one will look after crusher and two will unload into the hopper.
3. With two operators, one will be in car and one in care of the crusher. In this case, the man in charge of crusher will assist the other in changing cars and opening traps.
4. If two men constitute the gang, the one in charge will care for the crusher. If there are three men on the gang, the one in charge will assist in unloading.
5. The man in charge will start and stop the crusher and conveyor and see that the coal is dumped in the proper bunker. He will also weigh the cars, make out the time cards and change the time cards.
6. This task will not apply when weather conditions are such as not to permit the men to work continuously and unhampered. It is the duty of the foreman to determine such conditions.

Method

(*a*) One man takes a rope and hooks onto the empty car.
(*b*) The other man starts the motor and tightens the rope.
(*c*) The motor pulls the car ahead and out of the way.
(*d*) The first man removes the rope and carries it to the next loaded car.
(*e*) The motor tightens the rope and pulls the loaded car into position.

DETAILS AND TIME-VALUES

	1 Man in 62-Ton Car Min.	2 Men in 52-Ton Car Min.
A—Carry rope	.4	.4
B—Start motor	1.0	1.0
C—Pull away empty car	.4	.4
D—Carry rope to next car	1.0	1.0
E—Pull next car to position	1.5	1.5
F—Put away rope, get shovels	.7	.7
G—Open traps	1.8	1.7
H—Hammer loose coal out	12.0	12.0
J—Shovel out remaining coal	120.0	33.0
K—Clean tracks	1.6	1.6
L—Close traps	2.0	2.0

Synthesis

One man in car, one man in crusher estimated on basic averaging 45 tons per car:

$$A + B + C + D + E + F + G + \frac{(H + J)\ 45}{62} + K + L = \text{time per 45-ton car}$$

$$.4 + 1.0 + .4 + 1.0 + 1.5 + .7 + 1.8 + \frac{(12.0 + 120.0)\ 45}{62} + 1.6 + 2.0 = 106.2 \text{ min.}$$

30 per cent for incidental delays and fatigue, allow..... 31.8

Total time allowed per car of 45 tons.....138.0 min.
Total time allowed per ton unloaded..... 3.0
Task in hours per ton ..... .05 hr.

Two men in car, one man in crusher. Estimated on basis of 20 tons. (Amount when capacity of conveyor equals task of unloading, see separate instruction.)

$$A + B + C + D + E + F + G + \frac{(H + J)\ 20}{52} + K + L = \text{time per 20-ton car}$$

$$.4 + 1.0 + .4 + 1.0 + 1.5 + .7 + 1.7 + \frac{(12 + 33)\ 20}{52} + 1.6 + 2.0 = 27.6 \text{ min.}$$

30 per cent for incidental delays and fatigue, allow 8.3

Total time allowed per car of 20 tons.....35.9
Total time allowed per ton..... 1.8
Task in hours per ton ..... .03 hr.

Check on Task

The capacity of the coal conveyor is 40 tons per hour. It is evident, therefore, that the operators cannot work faster than the coal is carried away.

40 tons per hour—.025 hr. per ton
—.25 hr. per ten tons

Allow 20 per cent incidental delays:
.25 .05—.3 hr. per ten tons.

So 0.3 hours per ten tons should then be our task for all cars, since it applies to all containing more than 20 tons, and no cars contain less than 20 tons.

Bonus

Twenty-five per cent bonus will be paid figured on time allowed for unloading.

When ready to start on a car, the power plant clerk will issue the regular time card, form G-126, and stamp the time of starting and the time of completing the job.

Complete instructions for calculating this bonus will be found in master set of instructions, under timekeeping, in office files.

Approved .....
General Superintendent
O.K. .....
Vice-President

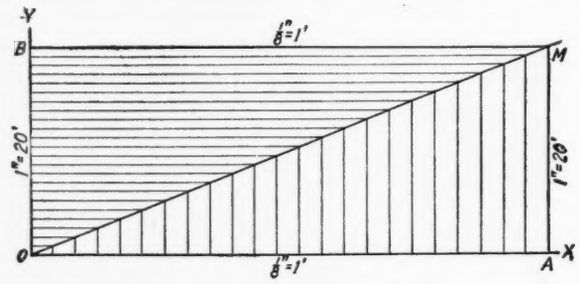
Right Out of the Plant

Diagram Simplifies Changing Dimensions From One Scale to Another

IT IS frequently necessary to redraw plans to a different scale. If the job is a big one with many small details to be drawn in, and a pair of proportional dividers is not available, the work becomes tedious and much time is wasted.

A method that has been used to good advantage is a diagram similar to that shown in the sketch. The diagram may be constructed as follows: From point *O* draw horizontal line *OX*. At right angles to *OX* from point *O*, draw *OY*. From the scale on the old drawing measure off a distance *OA*. Erect a perpendicular *AM* equal on the scale of the new drawing to *OA* on the scale of the old drawing. Draw line *OM*. Erect perpendiculars, conveniently spaced, from *OX* until they intersect the line *OM*.

To use the diagram, set the dividers to a line of given length on the old drawing. With the dividers set in this position, set one point at *O* on the diagram. Let the



Horizontal lines represent dimensions at one scale and vertical lines the same dimensions at a different scale

other point fall on *OX*. From this point on *OX* swing the dividers until they form a perpendicular with *OX*. Shorten (or lengthen) the setting until the free end intersects *OM*. This setting is the length of the line on the new scale.

The perpendiculars to *OX* are guide lines to properly locate the correct position for the dividers where they intersect *OM*. These guide line may be colored alternately to prevent confusion.

If horizontal lines are drawn from *OY* to an intersection with *OM*, the reverse change in scale can be made by using *OY* as the base. This is indicated in the figure where the change can be made from $\frac{1}{8}$ in. = 1 ft. to 1 in. = 20 ft., or vice versa.

E. F. SEAMAN.

Houston, Texas.

What Causes Air Receiver Explosions?

IN the Oct. 1 number of *Power* Dr. Sanford A. Moss, commenting on my discussion of "What Causes Air Receiver Explosion?" in the Sept. 10 number, imputes to me a kind of inferior technical marksmanship in that I "completely miss the point" in the correct explanation of the explosions. Dr. Moss believes that the high temperatures sometimes attained in compressed-air practice are caused by leaky valves permitting a portion of the high-pressure air to return to the cylinder and be recompressed until an ignition temperature is reached. In the Oct. 15 issue P. A. Baumeister expresses the same belief.

Some of the advocates of the leaky-valve hypothesis use a calculation to show the increase of temperature attained by adiabatic compression. The first stroke brings the temperature of the air to $T_2 = T_1 \frac{(P_2)^{\frac{n-1}{n}}}{(P_1)}$ which, for 80 lb. gage and $n = 1.41$, is about 450 deg. F. Some of this hot air leaks back into the cylinder, and, apparently without dilution with cool air coming in through the inlet valves, is re-compressed, attaining a temperature, according to the foregoing formula, of about 1,100 deg. I do not recall reading the result of the third stroke, but according to the formula the temperature would be about 2,220 deg., and at the end of the fourth stroke about 4,140 degrees.

Of course, the foregoing is absurd, yet it is an example of the conclusions of false premises. Actually the leakage air is much diluted with air from the atmosphere; and the exponent in the formula for operating conditions is not 1.41, but 1.3, or less.

Let us assume a single-stage compressor with leaking valves and piston rings that permit the entrance on the suction stroke of enough high-pressure air to equal 25 per cent of the volume of the air in the cylinder at the beginning of the compression stroke. We shall also assume that there is no refrigerative effect from expanding air. The receiver pressure is 80 lb. gage and the piston has completed the first stroke and the temperature of the discharge air is, according to $T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{\frac{1.3-1}{1.3}}$ = 816 deg. abs., T_1 being atmospheric temperature of 530 deg. abs. or 70 deg. F. On the following suction stroke one-fourth of the air returns through the discharge valves at 816 deg. abs. and mingles with the three-fourths of the air from the atmosphere, which is at 530 deg. abs. According to the formula $\frac{PV}{T} = \frac{p_1 v_1}{t_1} + \frac{p_2 v_2}{t_2}$ the temperature of the mixture is 581 deg. abs. This air is compressed on the second stroke, with a final temperature of 895 deg. abs. The next suction stroke finds the temperature of the mixture 590 deg. abs. and the temperature of the discharge at the end of the third stroke 909 deg. abs. It should be noticed that there is a gradually diminishing increment of temperature of the discharge air. At the end of the fourth stroke the temperature is 911.1 deg. abs. and at the end of the fifth stroke 911.4 deg. abs.—a practical equilibrium of temperature. Subtracting 460 from the final absolute temperature we have 451 deg.—certainly not an incendiary temperature.

Assuming a leakage of 50 per cent, with no refrigerative effect on the expansion of the high-pressure air, we obtain by the foregoing method a temperature of 1,022.2 deg. abs. at the end of the eighth stroke, and 1,102.4 deg. abs. at the end of the tenth stroke. Subtracting 460 from the latter temperature we get 642 deg.—certainly not the

ignition temperature of the vapor driven from lubricating oil.

These comments are offered not as an accurate description of the effects of re-compression but as a convenient means of assuring us that it does not account for the incendiary temperature sometimes encountered in compressed-air practice. As a matter of fact, the leakage air expands and does work against the piston, with a consequent lowering of temperature, at least to the point in the piston travel where the re-expansion line touches the atmospheric line—Dr. Moss and Mr. Baumeister both agree to this. Just why the work of expansion should cease with the opening of the inlet valves, however, is not quite clear to me. The conditions are not similar to those of the Joule experiment, because he dealt with air expanding into a vacuum (later and more careful experiments disclosed that there is actually a slight drop in temperature—the Joule-Thompson effect), while in the air compressor the leaking air exerts a jet effect on the air coming in through the suction valves and both move forward with the piston—work, undoubtedly.

It seems to me that there would be no great difference in the final temperature whether it were a large or a small amount of leakage. With a large amount there is a greater refrigerative effect while expanding, which may result in a lowering of the temperature below that of the intake, depending on the influence of the jacket water on the heat of compression. A small amount of leakage would have its heat rapidly removed by expansion and by dilution with the comparatively large amount of cool air coming in through the inlet valves.

There is no doubt that air compressors are running under every possible degree of leakiness; so if leakage and re-compression are the causes of high temperature, then there should be many examples of overheated piping and receivers, and frequent explosions.

Some years ago I directed the overhauling of a compressor from which we had taken indicator diagrams whose re-compression lines crossed the atmospheric lines at nearly midstroke. The pressure was 70 lb. gage. There was a thermometer in the discharge pipe that showed the varying temperatures that come with the varying temperatures of the intake air. The observed temperature never reached 400 deg. If re-compression was a cause of high temperature it should have been demonstrated in this case.

On another job was a motor-driven compressor serving a rock quarry. It had been bought second hand but was presumably in good condition. The compressor met the needs of the situation until the addition of a small drill to the quarry and a few lines about the plant found it inadequate. An increase in speed of the compressor or a reheater at the quarry was considered, but a comparison of the rated capacity of the compressor with the actual air consumption disclosed that the compressor was far behind in output, although it had received the best of attention during the short time it had been in use. It was decided to overhaul the compressor. A Sunday was spent at the task. Much coke, a considerable portion of which had become softened by the soap and water used as a part-time lubricant, was removed from above the valves, and the piston rings were renewed. On Monday morning, with all the air tools in operation, the unloader functioned at every few strokes of the compressor, so when the opportunity came the motor pulley was replaced with a smaller one to obtain reasonably quiet operation. An indicator was not available, nor was there a thermometer in the discharge pipe; but there was no indication of overheating, although the attendant had the rather inelegant habit of spitting on the discharge pipe—a practice that he assured me was an infallible detector of overheating. Were leaks a cause of ignition temperatures, then there should have been some evidence of it in this case.

It should be borne in mind that this discussion concerns incendiary, or ignition, temperatures; not the temperature attained under the ratios of compression usual in ordinary single-stage operation. That ignition temperatures are obtained in high compression-ratio work, such as in Diesel engines, is common knowledge. But we are not dealing with such ratios of compression in compressed-air practice. That we have ignition temperatures in compressed-air practice is all too true. But reason and experience do not impel me to the belief that they are caused by leaky discharge valves.

Los Angeles, Calif. C. O. SANDSTROM.

Control-Failure Alarm for Motor Circuits

PROBABLY the greatest objection to automatic control systems is the possibility that they might fail to operate and remain inoperative for a considerable period without the knowledge of the attendant. In many cases such a failure might cause great damage to a product, or at least loss of the volume of output. One would therefore expect to find control-failure alarms incorporated in most automatic machines. The omission of this feature on many types of equipment is probably due to competitive prices and the consequent elemination, by the manufacturer, of every piece that is not absolutely necessary for the machine's operation. This may reduce considerably the first cost, but it is in many cases the source of a greatly reduced efficiency of operation.

Many of the ordinary types of automatic electric motor drives can be readily equipped with alarm signals that will call an attendant's attention to irregularities in their operation. These control failures are often due to external conditions on the power line or other necessary connections and are beyond the control of the equipment. They may also be due to protective devices functioning to prevent overload. No matter what the cause, it is important that someone be informed of the interruption in operation so that it may be investigated and quickly reme-

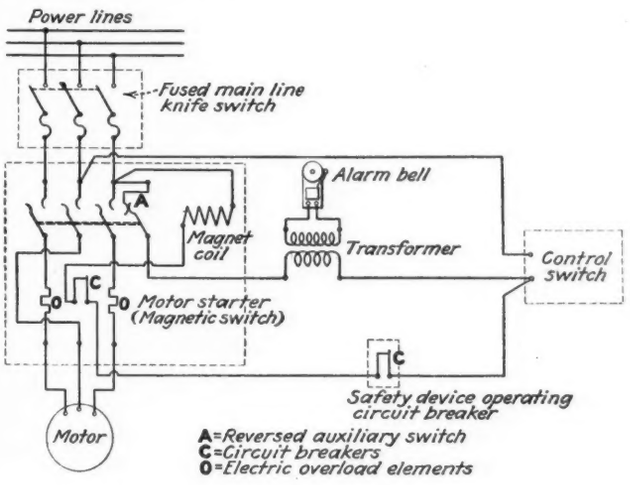


Diagram of motor starter and alarm connections

died. It is a common practice today to drive small equipment by alternating-current induction motors. Whenever allowable these are thrown directly across the line and are therefore controlled by a simple magnetic switch equipped with relays or circuit breakers to protect the motor from a maintained overload. An inverse-time element usually allows the necessary high starting current during the instant of starting.

In commercial switches of this type, a magnet or solenoid is energized by current taken from one phase of the line and passed through the control switch and circuit breaker. The magnet acts to close a normally open multipole switch. An auxiliary switch blade is usually provided for use with an instantaneous contact-type push-button station. With the maintained contact-type automatic-control switch, that may be a thermostat, float switch, limit switch, pressure switch or any of many other types, the extra switch blade on the motor controller is not ordinarily used. For alarm purposes it may without difficulty be reversed and converted into a normally closed switch that will be opened only when the magnet is energized. As shown in the illustration, a regular bell-ringing transformer is connected in series with this reversed switch and both connected to form a shunt, or parallel, connection across the magnet-coil breaker circuit. By referring to the illustration the following action may be traced:

If all conditions are favorable to normal operation, and both circuit breakers are therefore closed, the closing of the control switch will energize the magnet and close the motor switch, simultaneously opening the reversed auxiliary switch. This action will give current to the motor and start it.

Should either or both of the circuit breakers be open due to the existence of a condition unfavorable to normal operation, the closing of the control switch would not complete the circuit through the magnet and therefore the motor switch would remain open and the reversed auxiliary switch closed. Due to the position of the latter the circuit would be completed through the transformer and the alarm bell would ring until the attendant opened the main-line knife switch.

An alarm of this type will operate at any time when the closing of the control switch fails to close the motor switch. Should the motor be mechanically overloaded or its bearings frozen, it will draw an excessive current, which current will act on the electric protection and open the circuit breaker, and, in turn, ring the alarm. The failure of the windings of one phase of a polyphase motor will act in the same manner, provided the electric protection is properly adjusted.

In the ideal layout of this type all the circuit breakers would probably be of the hand-reset type. This feature provides for the attention of someone to any difficulty that causes the alarm to sound before the plant can resume operation. The fact that the alarm can be shut off only by opening the main knife switch makes it impossible for anyone to remedy the trouble, put the machine back into operation and leave the alarm shut off and incapable of sounding future warnings.

The system shown in the drawing has been used successfully in small and medium-size commercial refrigeration installations. In this application the safety device circuit breaker is a high-ammonia-pressure cutout, low-water pressure cutout or both. The control switch is either a maintained contact (mercury-tube type) thermostat, a maintained-contact switch operated by a pneumatic thermostat or a maintained-contact refrigerant pressure switch. A special snap switch is also incorporated in this layout, so that the plant can be manually operated independent of the control switch. This switch merely cuts out the control switch and takes its place.

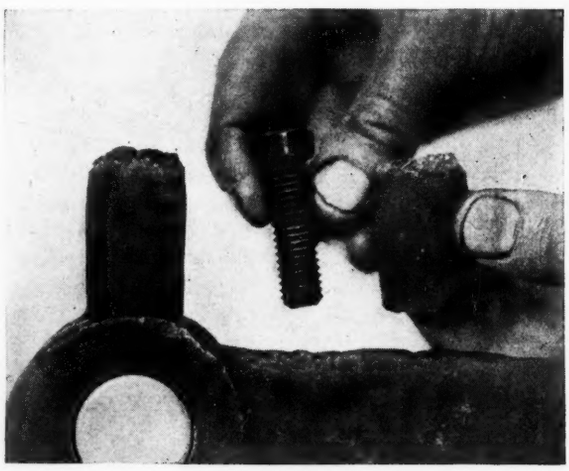
Variations of this control and alarm have been used with multi-point control automatic refrigeration, and they could be used with minor changes in any number of industrial and commercial automatic electric controls.

Philadelphia, Pa. LOUIS C. ROSENSTEIN.

Safeguarding Long Set Screws in Emergencies

IT IS, of course, against safety and even good judgment to use a set screw with a head extending any distance from the casting. However, many times in emergency repair work a long set screw is all that is available. A bit of hose small enough on the inside to go snugly over the square head will afford protection against and lessen most of the possibilities of anyone getting accidently caught by the projecting screw.

Cut the hose off a bit longer than the distance from the casting to the top of the set screw head. Round the top end of the hose off as shown. Clothing, gloves, and



Piece of rubber hose slipped over set screw

other things that might get caught and held by the head will run but little danger in even a forcible contact with it. Not the best of protection to be sure, but this will materially lessen the chances for mischief.

Missouri Valley, Iowa. F. W. BENTLEY, JR.

Testing for Leaky Piston Rings on Diesel Engines

LEAKY piston rings on those cylinders to which air is admitted can be detected as follows. Bar the piston to be tested to the top dead center and by means of a suitably placed lever hold the flywheel in position. Then slowly turn on the air so as to fill the clearance space, but do not open the valve sufficiently to apply full pressure.

After the cylinder clearance is filled with air, if the rings are a good fit the pressure gage on the air bottle will indicate a constant pressure. If the rings are leaky the bottle air pressure will gradually fall and a hissing noise will be heard. W. E. WARNER.

Brighton, England.

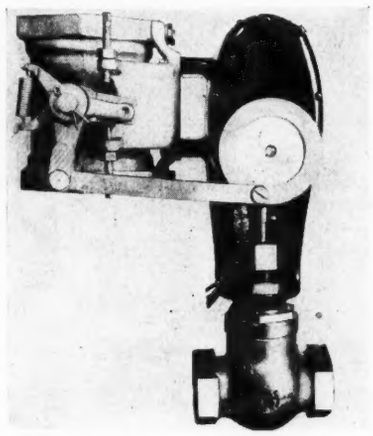
What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Regulators for the Control of Temperature, Pressure and Combustion

THE new line of industrial regulating equipment now being put out by the Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., includes units for the control of temperature, pressure and combustion. It comprises motor valves, pressure and thermostatic equipment, and devices for safeguarding combustion equipment in the event that oil or gas fires should be extinguished, or other emergencies arise.

The line of industrial motor valves includes equipment operating one globe valve and one butterfly valve, or two globe valves. Butterfly valves are also operated alone. The motor valves are obtainable in globe valve sizes from $\frac{1}{2}$ to 3 in., with or without a butterfly valve of 2 to 6 in., operated simultaneously. In each type the motor operates a cam through a train of spur gears, so as to fully open or close the valve being controlled. A ratchet device makes possible manual control of the valve at any time without disturbing the



Control operating one globe and one butterfly valve

electrical control feature. The line also includes motor- and solenoid-operated valves for shutting off oil or gas in heating installations.

Controlling instruments are provided in the form of temperature and pressure regulators of the mercury-switch type. The temperature regulators make use of a bi-metallic operating element arranged to be inserted in the vessel under control. The element is coupled to the adjusting mechanism, by which the control temperature is set to a mercury switch. The pressure controllers make use of a metallic bellows or a composition diaphragm to actuate a mercury switch. These are also adjustable to various control points.

The combustion controllers are of three types. One instrument contains a diaphragm, which is deflected when radiation from a furnace flame decreases, as when the fire is extinguished. It may then close valves or operate signals. Another type is adapted to control combustion, dependent upon flue-gas temperatures. This employs a bi-metallic spiral to make electrical contacts. These devices may be used to control valves or operate a line in the event that the temperature goes too high or too low. The third device employs a vapor pressure thermometer system to open a snap switch in case the temperature goes too high.

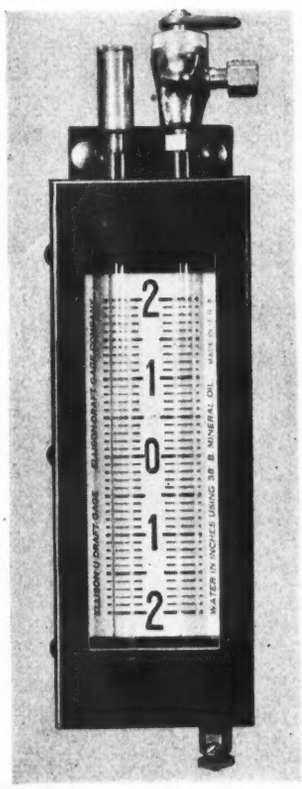
A control for unit heaters, in which some of the equipment described in the foregoing is combined with other apparatus previously developed in connection with building heating, is now available.

Cover-Type U-Gage

TO MEET modern requirements the Ellison Draft Gage Company, Chicago, Ill. has brought out a new design of covered U-draft gage, having a wide application for the direct reading of air and gas pressures, minus, plus or differential. It is available in the convenient ranges of 4, 6, 8, 12 and 16 in. of water, using red oil; and 5, 8, 10, 15 and 20 in. of mercury, or pounds per square inch, using mercury. The U-tube is inclosed in a compact dustproof case and is provided with fittings and sliding scale for zero adjustment. The scale has a $\frac{3}{4}$-in. sliding movement by means of an outside adjusting screw locked with a set screw.

Colored oil is used as the indicating liquid, as it evaporates only slightly and does not discolor the glass tube. The red oil in a tube of large bore over a white bristol scale with black figures $\frac{9}{16}$ in. high gives easy visibility. Calibration reads directly in inches and tenths of inches of water when using mineral oil, and with mercury in inches and tenths of inches of mercury or pounds and tenths of a pound per square inch.

The casing is of Armco iron-stamping in black finish. A removable front cover is provided, with a cork gasket to insure dust-tightness. The



New Ellison cover-type U-gage

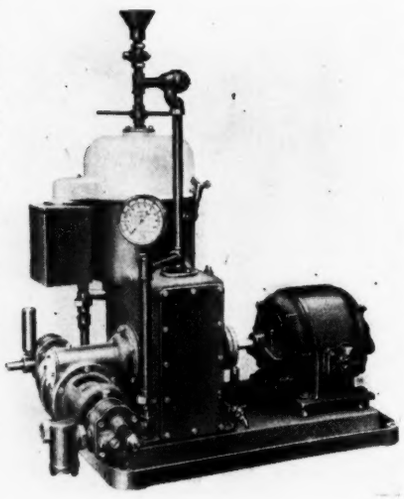
window in the cover is of $\frac{3}{16}$-in. plate glass.

Mounting of the gage is by two machine screws at the top, and for the larger sizes one additional screw fastens at the bottom. The U-tube is of heavy wall glass annealed, with $\frac{1}{4}$ in. bore. The ends of the U-tube are cemented into nipples, and a seal of not less than 2 in. is provided to protect the gage during momentary excess pressures beyond the scale range.

New Centrifugal Oil Purifier

A COMPACT direct-motor-driven centrifugal purifier of comparatively small dimensions for use in purifying the oil in lubricating systems and for various applications in process work has been added recently to the line of oil purifiers made by the Hydroil Corporation, Lebanon, Ind. The new purifier is a completely inclosed, vapor-tight, non-aërating machine suitable for handling lubricating, insulating or fuel oils, or any of the volatile oils. It is equipped with so-called wet and dry pumps, with piping arrangements to suit conditions. Standard-size ball bearings are used throughout, and lubrication is effected by a splash system, with all parts oiled from a central reservoir. The purifier may be equipped with a heater of the electric-immersion type to heat the oil to a degree where separation of impurities is most economically obtained, or it may be provided with a filter attachment consisting of a suitable number of sheets of filtering medium to remove the carbon and coloring matter.

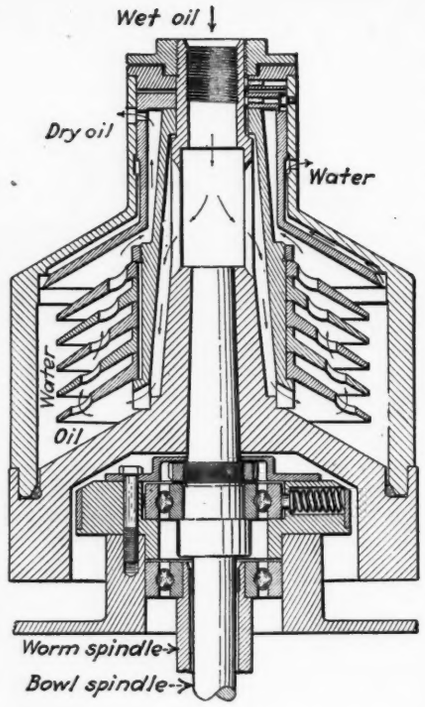
Among features adding to the convenience of operation are automatic control of the oil flow and automatic heat regulation control. The machine



Type D-50 centrifugal purifier

may be arranged with special base plates to fit any particular location for mounting either on the floor or the wall. The capacity of the purifier ranges from 300 to 500 gal. per hour depending upon the gravity or quality of the oil.

Reference to the line drawing will show the special features of bowl construction, such as the heavy section of the base to stabilize the bowl and prevent vibration from any unbalanced condition of the water or oil entering or leaving the bowl, the taper fit on the spindle, and the double spindle bearings. To permit ease of cleaning, the bowl shell is without ridges or projections, the bowl is divided at the bottom of the shell, and the separating disks may be removed as a unit or they may be revolved on the spindle after the shell has been removed, utilizing in this way centrifugal force to clean the base and the disks of any matter that adheres to them.



Section through the bowl of the purifier

Operation within the bowl is indicated by the arrows. The oil passes down through the stem and out into the oil passages of the disk holder, thence downward and out to the water line, where it is subjected to the maximum centrifugal force generated in the bowl. Water, sludge and other impurities, having a greater specific gravity than the oil, are thrown to the outside, and the dry, or light, oil is forced toward the center, where it passes up inside the dividing cone and out through the oil discharge. Sludge and solid matter are imprisoned against the bowl shell. Liquids that are heavier than oil, such as water and acids, pass upward on the outside of the dividing cone and out through the water discharge.

High-Permeability Iron

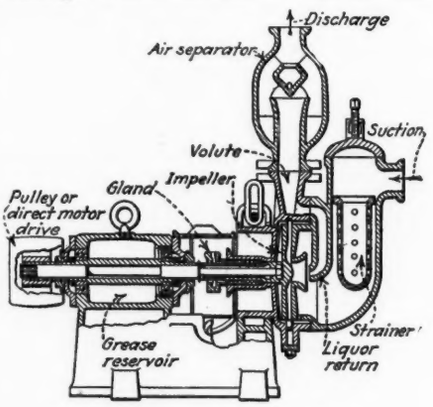
AN iron claimed to have high permeability and low hysteresis loss is being imported by A. Milne & Company, 745 Washington St., New York. The material is a Swedish charcoal, Lancashire iron product adapted for core parts where high permeability and low hysteresis loss are essential. The iron is a wrought or puddled metal and possesses altogether different properties from ingot metal.

It is obtainable in cold-drawn rounds, squares, flats, special shapes, and in cold-rolled, dead-soft annealed strips. Sizes for rounds and squares vary from $\frac{1}{64}$ to 3 in., and for cold-rolled strips, from 0.410x3 in. wide to 0.250x6 in. wide.

Self-Priming Centrifugal Pump

SELF-PRIMING, unusually deep stuffing box, and all parts that come in contact with the liquid being handled, of Duriron, are features of the new centrifugal pump, known as No. 80, being put out be the Duriron Company, Dayton, Ohio. The pump is rated at 60 gal. per minute against a head of 60 ft. and at a speed of 1,750 r.p.m.

An air separator is mounted in the discharge directly above the pump casing, which serves to return the



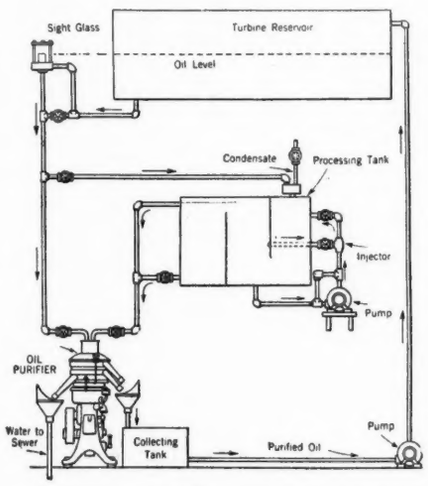
Self-priming pump of Duriron

liquid to the suction in case the suction column is broken. This feature insures proper starting of the pump at all times. The pump shaft is mounted on two anti-friction bearings, and may be direct-connected to a motor or equipped for belt drive. The impeller of the pump is of the open type, to prevent clogging when liquids containing solids are pumped. The strainer in the suction is readily accessible for cleaning by removing the cap.

Process for Maintaining Efficiency of Turbine Oils

A NEW process for maintaining the efficiency of turbine lubricating oil, known as the De Laval-Funk process, is announced by the De Laval Separator Company, New York City. Its operation is based on the fact, now generally accepted, that sludge is the real troublemaker in turbine lubrication and that the formation of this product is greatly accelerated by the presence in the oil and water of oxy-hydrocarbons, commonly referred to as acidity.

This new process is said to prevent the formation of sludge within the turbine-lubricating system by a method in which a portion of the oil in circulation is continuously brought into contact with condensate



Arrangement of processing equipment installed below the turbine

under conditions more favorable to the formation of sludge and the absorption by the condensate of oxy-hydrocarbons than those which exist in the turbine itself. Hence, sludges resulting from the formation of oxy-hydrocarbons and water are formed in the processing tank rather than in the turbine.

The quantity of sludge formed in the processing tank is said to be less than is produced by ordinary turbine operation, since the oxy-hydrocarbons, or acids, are absorbed by the condensate before they have had an opportunity to act upon the oil.

Referring to the illustrations, oil is continuously withdrawn from the bottom of the turbine reservoir, either by a pump or by gravity flow, through a sight-glass the outlet point of which is level with the minimum oil level in the turbine reservoir. This oil flows into the top of the processing tank, while at the same time a small stream of condensate enters the tank at the same point. This incoming mixture of oil and condensate is brought into intimate contact by means of baffles, agitator pump and mixing nozzle. The mixture of oil and water gradually finds its way to the top of the last baffle, from which it overflows to the purifier, and from this point clean oil is discharged into the turbine reservoir.

The sight overflow glass is bypassed with a valved line, so that the turbine reservoir may be completely drained and the entire contents put through the purifier if desired. Installation of a lock valve on this line insures against accidental drainage of the reservoir through carelessness. A valve is also installed on the line leading from the sight overflow to the processing tank, so that this tank may be cut out of the system in case the turbine develops a water leak and it becomes desirable to increase the rate of flow through the purifier.

The illustrations, which are self-explanatory, show the two general methods of installing the processing equipment.

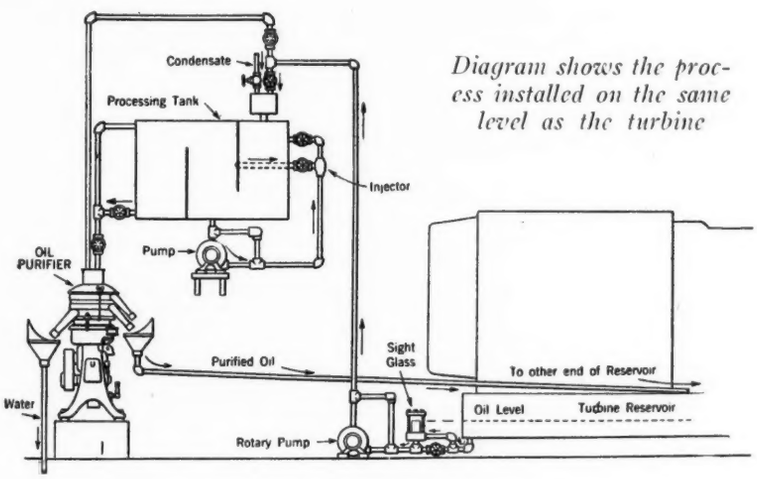
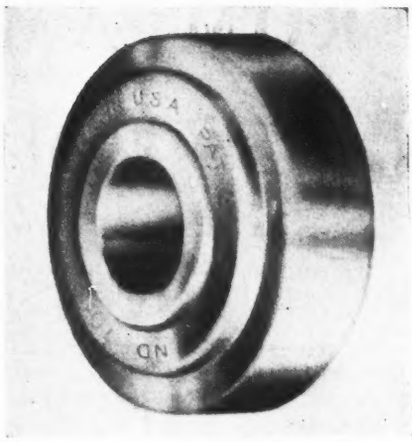


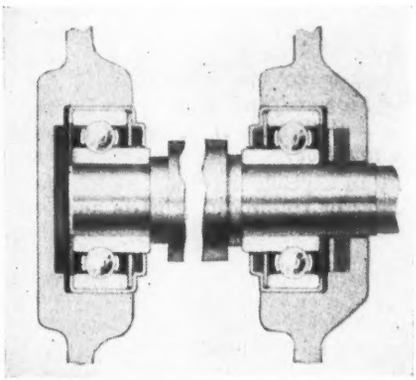
Diagram shows the process installed on the same level as the turbine



N-D-Seal bearing assembly

Single-Row, Self-Lubricated Ball Bearings

A SELF-SEALED, self-lubricated ball bearing designed to reduce mounting costs and at the same time increase bearing efficiency has been announced by the New Departure Manufacturing Co., Bristol, Conn. The new bearing, which is designated the N-D-Seal, is made only in the smaller sizes and consists of what is essentially a single-row ball bearing of the non-loading groove type permanently fitted into a metal shell. The shell is shaped on one side of the



Cross-sections of bearing showing typical mounting

bearing to contain a felt closure that fits over the outside diameter of the extended bearing inner ring, thus forming an effective seal both for the retention of lubricants and the exclusion of dirt.

Although the inner ring is carried slightly beyond the face of the seal to facilitate removal of the bearing, and to prevent interference between shaft shoulder and seal, the over-all width of the new bearing is less than the space occupied by a standard bearing of the same size, together with a separate inclosure member. Outside diameters and bores are standard.

FROM AMONG READERS' PROBLEMS

Conducted by L. H. MORRISON

EFFICIENCY OF A BOILER—*What is a reasonable boiler efficiency?* J. W. B.

The results to be expected from a boiler depend upon the type, the furnace design, the firing equipment and other factors.

A well-operated hand-fired boiler should have an efficiency ranging from 60 to 70 per cent. A stokered boiler will do from 70 to 78 per cent, and one should expect from 70 to 79 per cent with a pulverized-coal-fired boiler. But, after all, it's the man in charge who determines the efficiency. It is good if he is good.

PROPERTIES OF AMMONIA—*In an article in the Oct. 22 number of Power reference was made to a book of tables of the properties of ammonia and also to a Mollier heat diagram. Where can these be obtained?* H. R.

In *Power's* "Practical Refrigeration," Published by the McGraw-Hill Book Company, price $3, there is a complete set of the tables. The Mollier diagram can be obtained from the Bureau of Standards, Washington, D. C., for 30 cents.

CROSSHEAD WEAR IF ENGINE RUNS UNDER—*If an engine runs under, is it a fact that all crosshead wear is on the top shoe?* F.R.G.

It all depends upon the engine speed, weight of reciprocating parts and pressure conditions as revealed by an indicator diagram.

Typical diagrams for head and crank ends of a cylinder appear in Fig. 1. In Fig. 2 the diagram of the net forward pressure for the head end has been constructed, and it will be seen that, due to the compression in the crank end, the

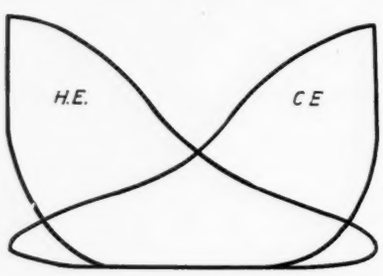


Fig. 1—Typical Indicator diagram

net head-end pressure becomes zero at *A* before the end of the stroke.

The line *BB* is the inertia-force diagram. When above the base line it is negative, that is, it pulls back on the piston, and when below the line it urges the reciprocating parts forward. Consequently, until the point *X* is reached the crankpin is pulling the piston, so that, with the crank running under the crosshead, it bears on the bottom guide until the point *X* is reached in the forward stroke. The same may occur on the crank-end stroke. Conversely, with the engine running over, all the wear

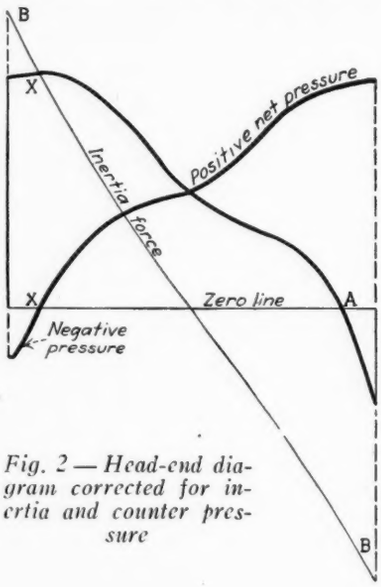


Fig. 2 — Head-end diagram corrected for inertia and counter pressure

need not take place on the bottom crosshead shoe.

Furthermore, we must not ignore the fact that the weights of the crosshead part of the piston rod and part of the connecting rod, which, acting downward, offset part or all of the guide reaction. For example, assume the engine has a 20-in. cylinder bore and that the steam pressure when the crank is vertically downward is 50 lb., with a 5-to-1 rod ratio, the guide reaction will be approximately $0.2 \times 50 \times 314 = 3{,}140$ lb. If the crosshead plus $\frac{1}{3}$ the rod plus $\frac{1}{2}$ the connecting rod weighs more than this amount, there will be a downward pressure on the lower guide at this point of the stroke, even ignoring inertia.

LEAKY POPPET VALVES—*We have a poppet valve engine on which the one-piece poppet valve leaks after regrinding. How can we correct this trouble?* C. V. L.

After regrinding the valve place it in the case. After tightening up the bolts, run the engine until all parts are heated to running temperature. Now quickly remove the valve cap and rub the valve on its seat. This will usually cause the valve to seat at all points.

CROWN OF PULLEY — *How can one figure the proper amount of crown to give a cast-iron pulley?* L.C.M.

In the design of a crowned pulley the following dimensions usually rule:

Let D = diameter of pulley in inches at edge of rim
t_1 = thickness of rim at edge
t_2 = thickness of rim at center of crown
w = width of face
s = thickness of belt to be used

Then $t_1 = \frac{3}{4}s + 0.0050$

$$t_2 = 2\,t_1 + \frac{w}{24}$$

SETTING SLIDE VALVE WITH LEAD—*What is the method of setting the valves of an upright slide-valve engine and how much lead should there be?* D.M.

The method is practically the same as for setting the valve of a horizontal slide-valve engine. Remove the steam chest cover and, with the eccentric fast on the shaft, turn the engine over by hand and find whether the admission edge of the valve overrides the admission edge of the steam port as much for one cylinder as for the other. If the amounts are not the same, they should be equalized by adjustment of length of the valve rod. Then place the engine on a center and set the eccentric to such a position that the valve will give the desired lead opening at the beginning of the stroke, but with the eccentric so placed with reference to the crank that the opening will be increased by turning the engine in the running direction.

Next, turn the engine over until on the opposite dead center and if the lead is not the same, obtain one-half the desired lead by readjustment of the valve rod and one-half by readjustment of the eccentric, repeating these adjustments on one end and then the other until the lead is equalized.

The lead opening to which the valve and eccentric should be adjusted depends on the size, design and speed of the engine, and also on the steam pressure and the load to be carried. The lead should be at least enough to obtain full steam-chest pressure in the cylinder at the beginning of the stroke when the engine is running at normal speed, and also as much as may be necessary, in conjunction with compression of the exhaust, to insure sufficient cushioning of the piston for quiet running of the engine.

Indicator diagrams should be taken to determine whether the final valve setting is correct.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

IN OUR system of treating boiler feed waters, we use the usual lime and soda-ash procedure, heating the raw water to 210 deg. F. before treatment. This gives $CaCO_3$, $CaSO_4$ and $Mg(OH)_2$, which are settled out and filtered before the water goes to the boilers.

The steam traps on the lines, after the steam is used in the engines and turbines, show a deposit of scale, which is mainly $CaCO_3$. We do not get deposits in engines or turbines. What is the explanation? H.C.N.

WE OPERATE what is perhaps the largest low-pressure steam-heating system in the world, our entire output of about 2,000,000,000 lb. in a heating season discharging to the sewer. In connection with this system, which is supplied from three plants, as it is 100 per cent make-up, we treat the entire boiler feed with lime and soda ash. Part of the steam is fed live into the heating mains, but the major part of it passes through non-condensing turbines and is exhausted into the mains.

We experienced considerable trouble with calcium carbonate being carried over into the turbine blading and out into the mains to the steam traps in only one of our plants, which carried about 70 per cent of the heating load. As our chemical treatment was in correct proportion, our feed-water temperature was at the boiling point, and we blew down sludge tanks and boilers sufficiently, we finally came to the conclusion that the speed with which our make-up had to pass through the treating system and filters did not permit the precipitates to "grow" sufficiently to settle out and be blown down in the sludge tank. This fact, coupled with insufficient filtering capacity, meant that fine, suspended calcium carbonate was carried into boilers and over with the wet steam into the turbines.

Part of the calcium carbonate in suspension in the wet steam was deposited in the turbine blading, but the bulk of it appeared in the traps out on the mains. These low-pressure traps are vented to prevent their becoming air-bound. It is my opinion that the suspended calcium carbonate in the moisture of the steam may have dissolved in water formed by condensation in the mains and remained in solution until it reached the traps. Here vapors released through the trap vents would cool the water, thus precipitating some of the calcium carbonate in the trap; and furthermore the increase in the concentration of $CaCO_3$ in the water in the traps by escape of vapors through the vents would tend to cause more precipitation. The solubility of $CaCO_3$ in water is very slight, even in boiling water, yet the vast volume of steam we deliver to the mains would permit the carrying over in suspension of such quantities of $CaCO_3$ as we found in our traps. We remedied the situation by providing more filtering capacity so that the velocity of the boiler feed through the filters was reduced, permitting a slower, more perfect filtering of fine, suspended particles of $CaCO_3$.

Indianapolis, Ind.

RAYMOND F. FORBES,
Indianapolis Power & Light Co.

CALCIUM CARBONATE present in boiler water is carried along with the steam from the boiler, not as $CaCO_3$. Due to the heat in the steam the $CaCO_3$ molecule is broken into CaO and CO_2. This is based on the following fact: Calcium carbonate, or limestone, as taken from the quarry, consists of one calcium, one carbon and three oxygen atoms. Now, when this limestone is put in a lime kiln the heat in the kiln dissociates the carbon atom and two oxygen atoms, thus driving off CO_2, and leaving behind CaO. In this form the calcium is carried in the steam.

The steam, as dry vapor, then, is composed of $H_2O + CaO + CO_2$, and flows as such with high velocity through engines and turbines. But when it reaches the lower exhaust temperature and pressure it begins to condense and again becomes H_2O, and the CaO will combine with the CO_2 and form $CaCO_3$. With the best of softening plant bicarbonates will find their way into the boiler and break down and liberate the half-bound CO_2. This, in turn, when not absorbed by some other ingredient, will travel along with the steam, and upon condensation will give $H_2O + CO_2 = H_2CO_3$ or carbonic acid. $CaCO_3$ and an excess of CO_2 in boiler water will show in dry steam as $CaO + (CO_2)_2 + 2\ H_2O$, and upon condensation will give $CaCO_3 + H_2CO_3$, or $Ca(HCO_3)_2 + H_2O$. This usually is a condition found in steam condensate by titration.

Samples of condensate taken from several boiler plants, and titrated with N/50 H_2SO_4 show an average causticity of 0.0; total alkalinity of 0.4; a trace of chlorides; and 0.35 grains hardness. Should this condensate remain in pipeline pockets or in lines with very little circulation for any length of time, corrosion will take place. But in traps that are open to the atmosphere the half-bound CO_2 will escape and leave $CaCO_3$ and H_2O behind. In time this carbonate will form a sediment. Should the steam leave the boiler wet and carry over boiler-water concentrate, then sediment will be found in line fittings, cylinder valves and turbine blading.

Milwaukee, Wis. CHARLES DICK.

WITH lime and soda treatment there is some residual calcium left in the treated water. This is usually in the form of calcium carbonate. This residual hardness passes on into the boilers and there concentrates until a point is reached where the calcium carbonate comes out of solution. From that point any hardness remaining in the treated water is converted to suspended solids, or "mud," in the boiler water.

Ultimately a point is reached where concentration of suspended solids, in conjunction with the dissolved solids also contained in the treated water, is sufficient to cause foaming or carry-over. In some cases, however, this reaction is not violent enough to be noticed in actual operation. The moisture content of such steam may be between 1 or 2 per cent, which would be sufficient to carry over considerable solids into the superheaters and engines. In many cases the solids in the steam do not deposit in the superheater tubes but pass on through in fine suspension. However, the velocity of steam through the engines is high enough to prevent any deposit there. Also, especially if the plant has superheaters, the moisture content of the steam will be insufficient to carry any calcium carbonate in solution, or to wet the mud sufficiently to form an adhering paste. However, as they arrive at the steam traps, the velocity of the particles is slowed down, and they have an opportunity to deposit as scale and sludge. Lubricating oil picked up in the engines will act as a binder for the calcium carbonate.

The slowing down of velocity and the presence of a small quantity of oil, are probably the reasons for the deposit appearing in the traps but not in the engines.

J. A. HOLMES,
Director of Service,
National Aluminate Corporation.
Chicago, Ill.

A Question for Our Readers

IF WE use a Zeolite system on the cooling water of a Diesel engine plant will the concentration of sodium carbonates effect the engine performance. G.R.M.

Suitable answers from readers will be paid for and published in the Dec. 24 issue.

Welding of Boilers, Pressure Vessels and Steam Lines

An Outline of the Present Situation

By C. W. Obert*

Union Carbide & Carbon Research Laboratories, Inc.

UNDOUBTEDLY one of the controlling factors relating to welding in boiler construction and repairs in this country has been the A.S.M.E. Boiler Code, which is operative in nineteen states and fifteen cities of the United States. This code, which is the result of the great uniformity movement that took form in 1911, permeates all of the stationary code jurisdictions in the United States with the single exception of Massachusetts—the pioneer state in enforcing boiler regulations. Aside from the nineteen abovementioned states and Massachusetts, the remaining states of the union have no regulations or restrictions on boiler construction or operation.

When the A.S.M.E. boiler code was first written, in 1914, the rules therein were limited to customary forms of riveted and forge-welded construction, and no reference was made to fusion welding as applied to either boilers or pressure vessels.

During the years that followed the issuance of the boiler code requests have come to the committee to investigate the new art of joining metals, and since 1916 the subject has been before the committee in one form or another almost continually. The committee has attempted to co-operate with individuals, organizations, and governmental bureaus in the endeavor to provide for recognition of welded joints, but it was not until quite recently, when definite co-operation was established with the American Welding Society, that it has received real assistance.

As the situation in the boiler field now stands, there are still no established provisions for welded construction, in a broad sense, other than for low-pressure heating boilers for pressures not exceeding 15 lb. for steam and 160 lb. for water heating, which may, of course, be wholly welded under the heating boiler code. However, the boiler code committee has taken some advance steps in the pressure vessel field that are reacting favorably upon the boiler field, and it is more than probable that something will be heard about some large-scale developments in boiler welding before long. It can be said, however, that welding is now admissible in power boiler construction to a considerable extent. In a number of details, opportunities have been found for applying welding.

The applications of fusion welding most generally used in boiler construction embrace a number of important elements, among which may be named the joints in boiler furnaces of both the staybolted type and the self-supporting type. These joints are now quite generally welded, for they are subject to compressive stresses only. Also, the seal welding of tube ends has been quite extensively practiced in fire-tube boilers, particularly in railway locomotive practice. In addition, fusion welding has for some time been used for the attachment of inserted nozzles, threaded outlets, brackets, supports and other mechanical fastenings to boiler shells for the connection and support of piping, auxiliary apparatus, and structural details.

One of the most interesting features of this development in welding, which is now actively before the boiler experts, is the promise of preventing the so-called "caustic embrittlement," which welded joints offer. There is a growing opinion that if boiler drums could be welded throughout so as to eliminate the microscopic cracks and seams that exist in riveted joints, the tendency toward concentration of caustic salts therein and consequent embrittlement of the plate would be eliminated. Unfortunately, however, no attempt has as yet been made to experiment with this application of welding under proper working conditions, although it is being definitely considered in a number of plants in which this plate-cracking trouble has been experienced. If the loss of riveted drums from embrittlement cracking should continue as it has during the past few years, it is quite certain that we shall soon learn of experimental installations of all-welded drums for water-tube boilers.

The A.S.M.E. unfired pressure vessel code exemplifies the first tangible results of the intensive studies of fusion welding made over a period of many years by the Boiler Code Committee. When it was issued, in 1923, it was considered an important advance; but the limits imposed therein on the application of welding were such as to narrow the use of welded construction principally to air pressure tanks of small sizes.

While very few states and cities have accepted the A.S.M.E. unfired pressure vessel code, the State of California took action in 1926 toward adopting the essentials thereof, except that it broadened the limits on welded construction considerably over those in the A.S.M.E. code; for instance, the diameter limit was increased to 60 in., the pressure to 200 lb., and the unit working stress in double-V longitudinal joints to 8,000 lb. per square inch. The Boiler Code Committee gave its sanction to the changes from its pressure vessel code, provided only that the state could enforce such regulations and restrictions as would insure sound and safe welding.

Since the original edition of the unfired pressure vessel code was issued, the American Welding Society has been working to liberalize the established rules for welded construction, and a step of great importance was taken when it formulated a recommended procedure for sound and safe welding, which was formally presented to the Boiler Code Committee last February. This recommended procedure established for the first time in code work a set of rules for welded construction which if followed out could be expected to insure safe welded vessels. The Boiler Code Committee after making a study of this procedure decided that it promises to furnish that connecting link between fusion welding and sound safe construction which is so greatly needed; and using it as a foundation, took steps to so revise the unfired pressure vessel code as to render it uniform with the California code. These revisions are now in process, awaiting publication before being officially approved and issued.

The above-mentioned revisions of the

During the past four or five years there has been a marked change in the position held by fusion welding in the boiler, pressure vessel, and piping fields. Part of this is due to change in public opinion, and part to improvements in welding processes and practices; probably the latter is the underlying cause. This paper outlines the present status of such welding and the attitude of the A.S.M.E. Boiler Code Committee and other authorities.

*Abstract of paper read before the 30th annual convention, International Acetylene Association, Chicago, Illinois, November 13-14-15, 1929.

A.S.M.E. unfired pressure vessel code will eliminate the present limitation of fusion welding to air vessels only, and will extend the diameter limit from 20 to 60 in., the pressure limit from 100 to 200 lb. per square inch, and the allowable unit working stress for double-V longitudinal welds from 5,600 to 8,000 lb. per square inch.

These extended limits are applicable, however, only where the recommended procedure, which is to be issued together with these revisions, is followed in detail, and the vessels are fully inspected during construction and at the time of hydrostatic test. It is provided in the code that if the requirements of this procedure are not followed the limitations that formerly existed will continue to apply.

The net result of this new departure is that only a well-equipped fabricating shop with qualified welders and considerable experience concerning pressure vessel construction will be in a position to take advantage of these new rules. This advance step taken by the Boiler Code Committee appears to be well thought out and wholly justified from every point of view.

As a result of this activity in welding rules, the State of Ohio has recently taken action to adopt the A.S.M.E. unfired pressure vessel code with the above-mentioned modifications included. These new rules will go into effect in Ohio on January 1, 1930. Oregon, which was one of the first states to enforce the rules of the unfired pressure vessel code, is now taking steps to modify the rules in accordance with the revisions under consideration, and thus keep its code up to date. Similar moves are being talked of in the cities of Seattle, Wash., and Detroit, Mich., although the author has not as yet learned of definite results.

The advance toward welding of higher pressure lines has undoubtedly been the result of the success and complete dependability of welded low pressure lines. At the present time there appears to be no hesitancy in welding piping systems for any pressure whatsoever, provided special precautions, including the annealing of welds, are adhered to for pressures in excess of 300 lb.

The states of New York and Pennsylvania have given some study to the question of pressure vessel rules, and may perhaps take action thereon within another year or so, if these revisions to liberalize the welding rules meet public approval and work out satisfactorily. The chief boiler inspector of New Jersey also favors the revisions in question, and is preparing to act along similar lines.

It is safe to state that the fields of power plant and heating piping have been the scenes of greater advance in fusion welding than those of boilers or pressure vessels. This is due perhaps to the general absence of restrictions of a legal nature pertaining to such construction. Fusion welding has found this field on unusually fruitful one, in view of its particular adaptability to the types of fittings and classes of materials used therein.

Probably the greatest single impetus was given to this development by the large industrial plants that maintain both piping and welding gangs. Under emergency conditions, their welders would be called in and found to be able to handle erection or repair work in a safe and dependable manner in a fraction of the time needed for the ordinary threaded or flanged fitting methods of piping. It is well known that the quality of low-carbon steel used in making ordinary commercial grades of pipe lends itself admirably to this purpose and has greatly facilitated not only the early attempts but also the more general use of the process. As a result, the possibilities of welding were soon demonstrated, and its use has thus developed from experimental and emergency attempts to large-scale operations.

The particular type of welding operation that seemed to prove most effective in the above direction was the forming of tees and ells with eccentric branches so disposed as to insure complete drainage or otherwise facilitate flow through the mains. Where this purpose would be difficult of accomplishment with cast or forged fittings, it is simplicity itself when welding sections of pipe together to form fittings.

Welded construction was first used for comparatively low-pressure pipe work, including exhaust systems, vacuum lines and other construction where tightness rather than strength was the prime requisite. The advance toward welding of higher pressure lines has undoubtedly been the result of the success and complete dependability of such low-pressure lines, and at the present time there appears to be no hesitancy in welding piping systems for any pressure whatsoever, provided special precautions, including the annealing of welds, are adhered to for pressures in excess of 300 lb. per square inch. Such welded construction has now developed to the point where well-equipped piping concerns are prepared to weld with either butt or cupped joints in regular line piping work, and fabricate branches, tees, ells, reducers and other special fittings. It is customary to subject such piping connections to hydrostatic pressure tests of approximately the following ratios:

Working Pressure Lb. per Sq.In.	Hydrostatic Test Lb. per Sq.In.
150	400
300	750
400	1,000
600	1,500
900	2,000
1,350	3,000

It was not until within the past three or four years, however, that the prestige of welding as a working tool in the piping field began to attract the attention of the contractors' organization—the Heating and Piping Contractors National Association. This association, urged by some of its influential members, began a serious investigation of the possibilities of invasion of their field by this form of construction, a committee of experienced piping men weighing the arguments for and against it.

One of the most interesting features is the promise of preventing the so-called "caustic embrittlement" by the use of welded joints. If the loss of riveted drums from embrittlement cracking should continue as it has during the last few years, we may soon learn of experimental installation of all-welded boiler drums.

The Heating and Piping Contractors National Association has a special committee at work on the problem of welded piping construction. Through its efforts an exhaustive study has been made of this practice as it is found under varying conditions in both power plant and industrial uses, with the result that a manual of standards for welded piping construction is being prepared.

It is perhaps in this phase of the development problem that oxy-acetylene welding has its greatest opportunity. The training of steam fitters to operate on both cutting and welding is a direct approach to business in this field, and should not be overlooked. Oxy-acetylene has a decided advantage in this because, as a piping contractor recently advised the writer, they necessarily have an oxy-acetylene cutting outfit on the job at the outset to cut the pipes to length, make structural changes, etc. It is therefore merely a step further to use the same agency for joining the pipes, instead of the laborious operation of transporting to and from a threading machine and then providing the fittings besides.

As previously stated, power and heating piping systems have so far been subject to very little restriction of a legal nature. In fact, there are no restrictions on piping in most of the states and municipalities in which effective boiler regulations are in force. The State of Michigan has been somewhat of a pioneer in this respect, having formulated in 1925 a set of regulations and code for the *welding* of steam piping. This code is administered under the Michigan Department of Labor and Industry, but the writer has been unable to learn to what extent it has been enforced.

In Ohio, the Industrial Commission is now in the process of formulating a complete code for piping systems, including steam, hydraulic, pneumatic, and refrigerating piping, for all of which definite and practical provisions for welding have been included.

RECENT PUBLICATIONS

THE TRANSACTIONS OF THE FUEL CONFERENCE, WORLD POWER CONFERENCE. Percy Lund, Humphries & Co., Ltd., London, 1928. Four Volumes. Leather; 6 x 9¾ in.; illustrated; 4,241 pages. Procurable from G. E. Stechert & Company, 31 East 10th St., New York City. Price, $72.

THESE volumes are made up of the papers presented before the Fuel Conference of the World Power Conference, held in London last year. Three of the volumes contain these papers, while the fourth is an index. Included in the volumes are 158 articles, of which 12 are in French, 33 in German and 113 in English.

Part of volumes II and III is devoted to the utilization of fuels for power purposes. These papers were reported at some length in *Power* for Oct. 9 and Oct. 30, 1928. Subjects covered include coal as a power plant fuel, pulverized coal burning, oil engine fuels, high-speed oil engines, Diesel engine supercharging, waste heat recovery, and research. As a reference, the set has value, but it is too bulky for the engineer's library.

THE SOVIET UNION LOOKS AHEAD. Published by Horace Liveright, Inc., New York, 1929. Cloth; size 5½ x 7½ in.; illustrated. Price, $2.50.

BEHIND the scenes in Soviet Russia there has been transpiring one of the greatest experiments in the socializing of a nation that has ever been attempted in the history of the world. What the success or failure of the Soviet government has been would be difficult to appraise, since the reports of the many investigations are so at variance. Some of these reports would lead to the conclusion that the great government melting pot was a horrible failure, while others paint a picture of its success. Be these as they may, it must be admitted that the Soviet government has an ambitious five-year program for economic reconstruction, as outlined in this book.

An indication of what is meant by the "Soviet Union Looks Ahead" is seen in the proposed power program. In the year 1927-1928 the total power production in the Soviet Union amounted to 5.1 billion kilowatt-hours. This is to be increased to at least 22 billion by the end of the five-year period 1932-1933. The 520,000-kw. capacity installed in central regional stations at the beginning of the period is to be increased to 3,100,000 kw. by the end of the period. This development involves 42 projects, of which 32 are reported to be under way. The largest is the Dneiper hydro-electric plant, which when completed will have a capacity of 636,000 kilowatts.

In the ten chapters and four appendices is an outline of future development that affects practically every activity of the national life. Many charts and tables are included that show the status of the various industries, labor, education, etc., as of the year 1927-1928 and what it is expected to be five years hence. The book presents the most comprehensive attempt at government planning that has probably ever been made and is well worth reading for this reason alone.

DESIGN STANDARDS FOR OXWELDED STEEL AND WROUGHT-IRON PIPING. Published by the Linde Air Products Co., 30 East 42nd St., New York, N. Y., 1929. Paper; 6 x 9 in.; 67 pages; numerous drawings and tables. Distributed free.

ALTHOUGH this booklet is issued by a company engaged in the manufacture of welding materials, it cannot in any sense be classified as a catalog. The contents, as the title indicates, are devoted strictly and entirely to design standards. This booklet should be extremely useful to the engineer or architect called upon to lay out welded piping systems, because of the clear and practical manner in which the subject is presented.

Subjects covered include: Application of fundamental welding designs, welded line joints of various types, reinforced welded joints, pipe flanges, welded tee and branch connections, fabricated and notched bends, reducers, bull plugs, welded pipe anchors, welded pipe headers.

An appendix gives the dimensions of welded steel and wrought-iron pipe, tables of the strength of oxy-acetylene welded pipe joints, formulas for fabricating multi-piece bends, dimensions of standard pipe bends, data on "tube turns," dimensions of welding flanges, and seamless welded connections, details of pedestal elbows, etc.

WATER RESOURCES PAPER NO. 57—The Dominion Water-Power and Reclamation Service, Department of the Interior, of Canada, has recently issued volume 57 of its water resources papers, which deal with the surface water supply of Canada. This number contains the results of investigations made by the Dominion hydrometric survey during the climatic year Oct. 1, 1926, to Sept. 30, 1927, in the Provinces of Alberta, Saskatchewan and Manitoba and the extreme western part of Ontario. The report contains a short explanation of the purpose and scope of the work and 206 pages of stream-flow and meteorological data, with an index map showing drainage areas and the location of gaging stations. Copies may be obtained free of charge on application to the Director of the Dominion Water Power and Reclamation Service, Ottawa, Canada.

MEN AND MACHINES. By Stuart Chase. The MacMillan Company, New York, 1929. Cloth; 5 x 7 in.; illustrated; 354 pages. Price, $2.50.

MUCH speculation has appeared in books, periodicals and newspapers as to the effect to be expected from the rapid growth of the use of machinery in all human activities. Prophets have arisen to foretell a day when we will all be slaves to machines, bound to serve their necessities, unable to exist without them. Still others see the extended mechanization of life as the forerunner of the millenium, looking forward to a time when all work is automatically done by machines; and man, a creature of leisure, is at last free from Adam's burden.

It is futile to look so far into the future that we leave reality behind. It is profitable to examine the present conditions of things, see what portends for the immediate future and to be prepared to face new eventualities with open eyes.

This is what Stuart Chase has done in "Men and Machines." The book has much in it that is hopeful—also much that is not so encouraging. Above all, it is an honest attempt to discover what may happen in an increasingly mechanized world when only known facts are considered. Engineers, men who live by and with machines, will find stimulation and interest in Mr. Chase's new book.

CONSTITUTION AND NATURE OF PENNSYLVANIA ANTHRACITE, WITH COMPARISONS TO BITUMINOUS COAL. By H. G. Turner. Technical Publication No. 234. Published by the American Institute of Mining and Metallurgical Engineers, New York, 1929. Paper; 6 x 9 in.; illustrated; 17 pages.

A PREPRINT of a paper to be presented at the February, 1930, meeting of the institute. Discussion is invited, to be presented in person at that meeting, or sent in writing to the secretary.

The paper is an account of microscopic studies of anthracite with comparisons to high-rank bituminous coal. It is shown that anthracite exhibits all of the structural characteristics of bituminous coal, except that it generally fractures into more conchoidal, less rectangular, lumps. Its structural constituents are the same, but, because it has undergone more severe conditions as to pressure, etc., it is more compact, denser and of superior toughness.

The three chief components are chemically and physically different in the two coals, yet their differences are of the same order when a given component of one is compared to a like component in the other. The inorganic constitutents are not combined chemically with the organic matter to any marked extent. Anthracite has greater adsorption powers than bituminous coal. The fixed ash of both is about 0.5 per cent. The bulk of the ash is confined to the duller laminae, from which it can be removed in part only after fine grinding, provided a mechanical method is used.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Spot ✻ News

TWENTY-SEVEN *of the country's most prominent public utility men laid plans for an extensive construction program at the final conference, Nov. 27, of the series called by President Hoover for the purpose of maintaining economic stability and keeping business activities at normal levels. A program was pledged involving a total expenditure in* 1930 *of* $1,810,000,000 *for new construction, expansion of facilities and maintenance of existing properties.*

* * *

IN A TEST *conducted by the New York Edison Company recently, 6,000 tons of coal that were in a West Virginia mine on a Tuesday, were, on the following Friday, being fed under boilers of one of the company's power plants in New York City. The purpose of the test was to determine the minimum time in which unmined coal from the company's regular sources could be put into service on the system.*

* * *

LOCK *12 hydro-electric development of the Alabama Power Company, on the Coosa River, Ala., was officially designated on Nov. 23 as "Lay Dam" in honor of Captain William Patrick Lay, founder and first president of the power company.*

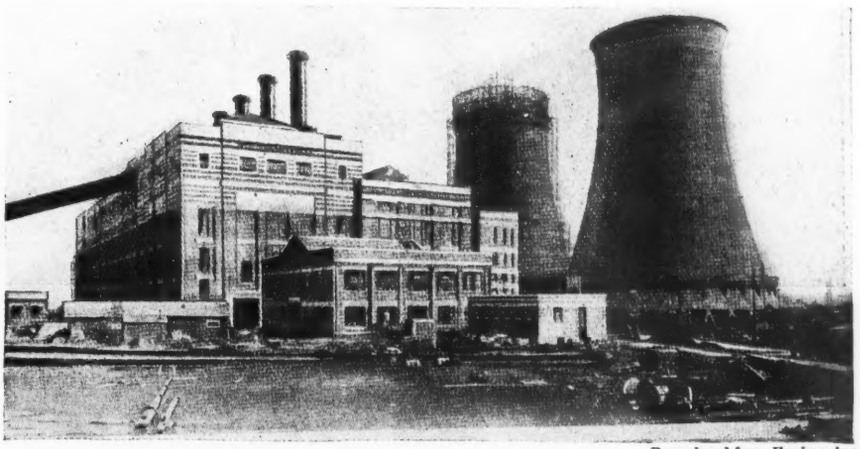
* * *

AS CONSTRUCTION *of Boulder Dam would be delayed indefinitely by litigation challenging the constitutionality of the law, Secretary of Interior Wilbur will reserve decision on the allocation of power from the dam until the middle of this month, in the hope that Arizona will have composed its differences with California by that time.*

* * *

NEW ORDERS *for 1,712 steel boilers were placed in October, as reported to the Department of Commerce by 80 manufacturers comprising most of the leading firms in the industry, compared with 1,910 boilers in September and 1,803 in October, 1928.*

Britain's Large Pulverized Coal Plant Now Ready for Operation



Reproduced from *Engineering*

Hams Hall Station, Birmingham, England, showing large cooling towers

INITIAL installation of 60,000 kw. in England's new large pulverized-coal plant was completed recently at the Hams Hall Generating Station in Birmingham. Officiating at the opening ceremony, the Duke of York put into operation another section of Britain's great national power scheme.

With an ultimate capacity of 210,000 kw., this project is one of the first magnitude. Contract for the present equipment was placed in July, 1927, the total price being $6,682,000. Cost of the completed station is estimated at $17,500,000. While the present installation is now in operation, an immediate addition of 30,000 kw. will be necessary to take care of Birmingham's growing demand for electricity, it is contemplated.

The present plant consists of two 30,000-kw. turbine generators. The boiler plant comprises five Babcock & Wilcox boilers of the sectional-header type, with superheaters each of 190,000 lb. evaporation per hour normal and 228,000 lb. overload, operating at 375 lb. pressure and 710 deg. F. The boilers are equipped with Lopulco pulverized-fuel combustion chambers, with five type-R turbulent burners giving completed combustion in a 10-ft. flame.

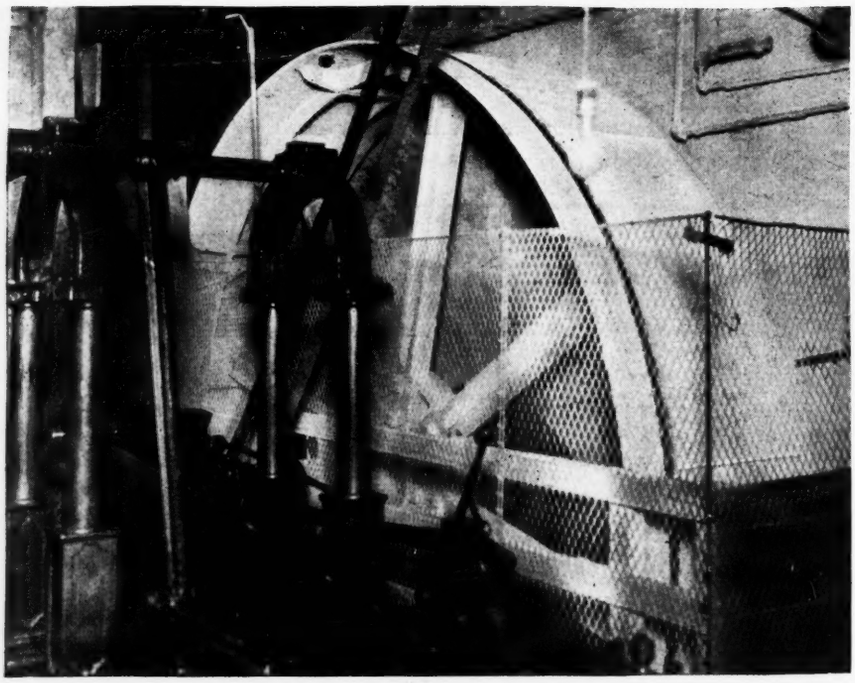
Pulverized fuel is supplied on the direct system. There is one pulverizer to each burner, grinding four tons of low-grade coal per hour, with 25 per cent moisture and 20 per cent ash, giving 100 tons of fuel per hour for the complete plant. The over-all thermal efficiency from the raw coal to the switchboard is calculated at 23 per cent, with a possible 87.5 to 90 per cent boiler efficiency on continuous running.

The installation also includes two enormous reinforced concrete towers of circular section, having a height of 215 ft. and a base diameter of 175 ft. Each is capable of reducing 4,000,000 gal. of water per hour from 93 deg. F. to 76 deg., and operates in conjunction with a cooling reservoir of 5,850,000 gal., one month's capacity.

The choice of the site of the station was influenced by the proximity of coal fields and the large quantity of water available for use in surface condensers and the cooling towers.

Z-Canyon Project Postponed

Development of the proposed Z-Canyon project on the Pend Oreille River in northeastern Washington, for the generation of 760,000 hp. at a hydro-electric plant at a cost of $20,000,000, rests with the future, according to the statement of Hugh L. Cooper, of New York, who recently stopped in Spokane, en route from Russia where he inspected the Dnieper River project. Mr. Cooper declared that the general uses to which electric power could be put in the district surrounding the project are not yet sufficiently developed to permit construction of the project. His permit expires in the spring but carries a year's extension privilege.



SERVING since 1855, this 33-in. double-ply leather belt manufactured by Alexander Brothers, is still used on the 15-ft. flywheel of a 100-hp. steam engine in the plant of Samuel H. French & Company of Philadelphia to drive an 8-ft. line-shaft pulley. Another Alexander 24-in. belt has been operating in the plant since 1855.

Gas Welders Hold Annual Meeting in Chicago

From Nov. 13 to 15, inclusive, the International Acetylene Association held its thirteenth annual convention in Chicago, at the Congress Hotel. A wealth of good material dealing with the various phases of gas welding was presented to nearly 350 delegates in attendance.

A feature of the meeting was an an 86-page report of the oxyacetylene committee, outlining the progress of the industry technically and in its application and expansion. The various technical sessions were devoted to specific branches of the subject. There was a session dealing with the present attitude of authorities toward the welding of boilers, pressure vessels and steam lines and a critical discussion given of the methods of testing and the significance of the results; a chemical session outlining some recent uses of the oxyacetylene process in the chemical industry, with a second paper dealing with the welding of copper; a welded piping session in which the welding of steam piping in high-pressure and heating installations and the welding of tube ends were discussed, in addition to the presentation of several papers going into safe welding practice and fire losses attributable to the careless use of the blow pipe. At the final session there were papers dealing with the application of the automatic cutting machine to welded steel products and oxy-acetylene welding in the manufacture of pumps.

Final business of the convention consisted of committee reports, election of officers and the award of the Morehead medal for 1928 to the late Samuel Wylie Miller for research in the metallurgical and mechanical engineering phases of welding. It will be recalled that this medal was established by John M. Morehead in memory of his father, John Turner Morehead, who was the pioneer of the acetylene industry. The medal is presented annually for outstanding work in the development, manufacture or use of acetylene and its various products. New officers elected for the coming year were: president, C. A. McCune, director of research, American Chain Company; vice-president, W. E. Flannery, vice-president of K-G Welding & Cutting Company, Inc.; secretary and treasurer, A. Cressy Morrison, of the Union Carbon & Carbide Corporation.

A.S.T.M. Studying Coal-Pulverizing Properties

Committee D-5 on coal and coke of the American Society for Testing Materials reports progress in the development of a laboratory method of test for the determination of pulverizing characteristics of coal in connection with the preparation of powdered coal. A promising method of test consists of grinding sized portions of the coal in ball mills equipped with steel balls, and estimating the extent of pulverization by means of a size test. Coals of known commercial pulverization characteristics are used in the laboratory experiments.

Steel Mills to Install Largest Motors

The largest single installation of synchronous motors in steel mills will soon be made at the National Works of the National Tube Company, McKeesport, Pa., with six large Westinghouse machines. One of these mills will be equipped with one 2,000-hp. and two 3,500-hp. synchronous motors. A second mill will have one 1,000-hp. and two 2,000-hp. motors. These machines will be designed with inclosing covers to prevent dirt and dust from getting into the motor windings. The covers will be connected to air-filtering equipment to clean the air and force it into the motor at a pressure of about $\frac{5}{8}$ ounce.

Another special feature of the design of the machines will be their high-peak-load rating. Each of the machines is designed to carry 350 per cent load at frequent intervals. Their windings will be insulated for high temperatures, and their load-carrying capacity will be far in excess of any machines that have been used for driving similar mills. Each will have a field-sustaining relay to maintain the strength of the field under high load conditions.

Continued Growth Predicted by Power Commission

Continued expansion of the power industry in the United States is forecast by the Federal Power Commission in its ninth annual report made public Nov. 23 by the Secretary of Interior, Ray Lyman Wilbur, who is also acting chairman of the commission. A new high record for energy production will be established during 1929, and a vast construction program will have to be undertaken to provide the new generating facilities required for the rapidly increasing demand, the report cites.

Applications filed with the commission up to the close of the fiscal year totaled 1,002; licenses were issued in 373 cases which authorize in the aggregate an installation of 5,744,239 hp., while a total capacity of 2,652,066 hp. is generated from plants already completed, the report shows.

The report calls attention to the fact that the "electric power industry of the country continues to maintain an amazing growth, the rate of expansion during the past decade having been equalled by but few major industries.

"The generation of electrical energy by municipal and privately owned plants serving public utility purposes reached a total of 88,000,000,000 kw.-hr. in 1928, which represents an increase of 126 per cent over the annual production of ten years ago. Preliminary figures indicate that the increase of production in 1929 will exceed that of 1928, although the proportion generated by water power will be sharply reduced," the report shows.

This was due largely to the prolonged drought that affected the northern section of the United States and that

required the substitution of steam-generated energy to meet the deficiency of water power plants. The report adds that the country's electric energy requirements generated from water power has fluctuated between 34 and 40 per cent of the total.

The lack of constructive public co-operation in solving problems besetting prospective projects is an obstacle of great importance in hindering the water power development of the United States, the report cites. There is much litigation of water rights that should be determined on sound engineering and social principles instead of through the stretching of inapplicable laws and court decisions over the troubled field, and the control of certain abuses has led to unnecessary handicaps for legitimate enterprises.

The commission indicates in the report that public utility regulation should be handled by the states rather than the federal government. Being a local problem it will best be attained by local responsibility and opinion, it adds.

Long Beach Steam Plants Make Record Runs

Unit No. 10 in Southern California Edison Company's Long Beach steam plant, the 134,000-hp. turbine-generator placed in operation June 20, 1928, on Nov. 1, 1929, had completed 497 days of service. During this time, it had actually been in operation 10,165 hr. out of a total possible time of 11,928 hr. The total out-of-service time was 1,763 hr. The longest continuous service in which the unit was run at full load started Dec. 29, 1928, and continued for 2,241 hr. or until April 1, 1929. During its 497 days of operating life, the unit has carried an average load of 112,000 horsepower.

From Jan. 1, 1929, until 9:10 p.m. Oct. 28, the output of the Long Beach steam plants had reached the billion net kilowatt-hour mark.

U. S. Chamber to Formulate Water Power Policy

A picture in detail of the water power situation in this country will be reviewed by the United States Chamber of Commerce Committee on National Water Power Policies, under the chairmanship of Frederic A. Delano, at a meeting to be held at Washington, D. C., Dec. 9 and 10.

Various phases of power development, use and regulation have been under scrutiny by subcommittees, which will submit fact reports on the following subjects: "Federal and State Fact-Gathering Agencies for Water Power Resources"; "Present Status of Water Power Resources"; "Facts in Regard to Ownership of Water Power Resources"; "Comparison of Hydro-Electric and Steam Power"; "The Problem of Regulation"; "Rates and Rate Structure"; "Examples of Participation in Hydro-Electric Development by Governmental Agencies, Federal, State and Local"; "Hydro-Electric Development in Relation to Agriculture and National Defense."

Business Forecast

THE gradual slackening of business activity seems this week again to be proceeding according to schedule. This means that the slowing up is about what might be expected at this season plus what would be natural in the light of the abnormal or boom conditions that existed up to the middle of the year. There is little direct or conclusive evidence that the stock market collapse that has so far taken place has in any great degree accelerated the decline that would otherwise have occurred. We look for it to continue without marked change for the better, except for about the usual holiday increase in retail trade, until early in January.

If business could be talked down we should have had a more pronounced recession than has so far been seen. If it can be talked up, next year should be a record-breaker. But the first burst of sunshine following the President's conferences has been followed by a few scattered clouds of conservative reflection, and further activity of the statement-mills is not likely to swing the general course of business far from what is normal under existing actual conditions—*The Business Week.*

New A.C. Home Study Course Offered by Wisconsin

"Practical Alternating Currents" is the title of a new correspondence course announced by the University of Wisconsin. Simplified methods are used in the course, the only prerequisites being a knowledge of arithmetic and the ability to draw and measure straight lines and angles. The information that the electrician needs in working out the problems he is most likely to meet in the trade is presented fully and in detail, the announcement states.

Wisconsin University correspondence courses in electrical engineering, 28 in all, provide a comprehensive program of home study, including practical mathematics, essentials of electricity, theory and operation of alternating-current and direct-current machinery, illumination, central stations and distribution, wiring telephony, radio, measuring instruments, storage batteries, transient electric phenomena, etc. Some of the courses are credited toward a university degree. Information may be obtained from the University of Wisconsin Extension Division, Madison, Wis.

News of Canada

St. Lawrence Development Outlined by Sweezey — Carillon Power Rights Controverted—Power Corporation to Expend $55,000,000

FOUR big power sites on the St. Lawrence River between Lake Ontario and Montreal will provide 5,000,000 hp. with a regulated flow of 230,000 c.f.s., according to R. O. Sweezey, president of the Beauharnois Light, Heat & Power Company, who delivered an address recently before the Ottawa branch of the Engineering Institute of Canada. The tremendous power resources of the St. Lawrence were placed by Mr. Sweezey at 2,000,000 hp. in the international section of the river at Morrisburg and Cornwall, 2,000,000 at Beauharnois, where the head is 83 ft., and 1,000,000 at Montreal, in the Lachine rapids. Mr. Sweezey stated that the demand for power in Ontario and Quebec is doubling about every eight or nine years.

One of the significant statements in his address, which touched the high spots of the power situation along the St. Lawrence, was the hint that the Beauharnois company and erstwhile rivals on the north side of the St. Lawrence may some day join hands and divert all the water now available to Beauharnois and the Cedar Rapids Manufacturing & Power Company through the Beauharnois canal, thus developing much more power from the same quantity of water. Business co-operation between the Beauharnois and two other existing companies, he said, will make possible the development of a million horsepower at Beauharnois.

Carillon Controversy

Revival of the controversy over the Carillon power rights on the Ottawa River will take place at the conference this month between the dominion government and representatives of the Ontario and Quebec governments. The growing demand for more power in Ontario has caused the provincial government to seek new sources of electric energy, and as the Carillon power site is the potential development on the Ottawa River, it appears to be next in line. However, there are difficulties to be overcome; the power is one in which Ontario and Quebec have a joint interest, because, while the site proper is in Quebec, the power backs up into Ontario and is right on the boundary.

When this project was up for consideration a few years ago there was a controversy in Parliament that lasted for many weeks. It then had reference to the Georgian Bay canal scheme, the charter for which had been secured by the Sifton interests. Renewal of the expiring rights was sought, but in the face of opposition and obstruction this was withdrawn. It is believed that the matter will finally be disposed of through an amicable agreement between the provinces of Ontario and Quebec, both of which desire to share in the benefits

to be derived from development of this important site.

To Expend $55,000,000

Contemplated expenditures of $55,000,000 on the part of the Power Corporation of Canada group for further developments are expected to add over 44 per cent to the total combined capacity of the system. These additions to the various companies will come into operation progressively. When the present program of new developments and betterments is complete, the combined installed capacity will be in excess of 1,000,000 hp. This huge volume of power is practically one-fifth of the dominion's total development. The various companies in the group at present control undeveloped sites with a combined capacity of 1,065,750 horsepower.

Annual Statistical Issue of Electrical World

On Jan. 4, 1930, the annual statistical number of *Electrical World* will be published, bringing to its readers, as it does every year, a clear outline of the status of the central station industry at the end of the year. To put this information into quantitative form, several thousand individual statistical items will be compiled, and numerous charts used to present the data graphically. In addition, the data will be amplified and interpreted by those having an intimate knowledge of industry conditions. The only complete reference book of the industry, this issue requires for its preparation the collaboration of many nationally known contributors.

Scientific Book Club Organized

Two Nobel prize winners, Robert A. Millikan and Arthur H. Compton, professor of physics at the University of Chicago, are on the editorial and advisory committees of the newly formed Scientific Book Club. The new enterprise will furnish to its members each month the most significant and worthwhile new book in the scientific field, to be selected by an editorial committee consisting of Dr. Kirtley F. Mather, chairman of the editorial committee; Dr. Edwin G. Conklin, Dr. Harlan T. Stetson, Dr. Arthur H. Compton and Dr. E. L. Thorndike.

Each month a book-review magazine will be sent to every member of the club. This magazine will contain a full review of the designated book of the month as well as descriptive summaries of other volumes recommended by the committee. Members may choose the selected book or have the option of substituting any volume on the supplementary list. Books dealing with every branch of science will be reviewed by the committee. Astronomy, chemistry, physics, anthropology, psychology, geology and biology are some of the subjects that will be covered.

Coming Conventions

American Institute of Electrical Engineers. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Mechanical Engineers. Annual meeting at New York, N. Y., Dec. 2-6. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Twenty-Fifth Anniversary Meeting at Hotel Pennsylvania, New York City, Dec. 4-7. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

International Heating & Ventilating Exposition. Commercial Museum, Philadelphia, Pa., Jan. 27-31, 1930. Manager, C. F. Roth, Grand Central Palace, New York City.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Marine Engineers' Beneficial Association. Annual convention at Hotel Barlum, Detroit, Mich., the week of Feb. 10, 1930. Secretary, A. L. Jones, 9th St. and Mount Vernon Place, N. W., Washington, D. C.

Obituary

Walter Wells, veteran electrical engineer of the Province of British Columbia died recently on Bowen Island, B. C. Mr. Wells has been well known in the electrical industry of the province for the past 22 years.

Robert T. Huston, vice-president and superintendent of the Connersville Blower Company, died suddenly Nov. 14 of an acute heart attack at his home in Connersville, Ind. He had been connected with the Connersville company since its organization, in 1893, and in addition was prominent in civic work.

Benjamin Mortimer Hall, supervising engineer of the United States Reclamation Service for New Mexico, Texas and Oklahoma, died Nov. 20 at the age of 76 in Atlanta, Ga. He was with the reclamation service from 1904 to 1907, and also served as chairman of the Water Power Committee at the National Conservation Congress. He was the author of several works on water power and on other subjects.

Personals

William F. Ryan has joined Stone & Webster Engineering Corporation at the Boston Office as engineer in the mechanical division coming from the engineering departments of The Solvay Process Company and Atmospheric Nitrogen Corporation, with which firms he has been connected since 1924. Previous to that time he had spent several years with the Harry M. Hope Engineering Company, as steam engineer, and with the Interborough Rapid Transit Company on power plant operation and construction.

James D. Andrews, formerly with Armour & Company, of Chicago, is now at the Buffalo, N. Y., plant of the General Electric Company.

Dexter S. Kimball, dean of the Cornell University College of Engineering, has been appointed acting president of the university to take the place of President Farrand, who will be abroad for the next two months.

W. M. White, for a number of years mechanical engineer with the United Gas Improvement Company, of Philadelphia, has recently joined the engineering staff of Ford, Bacon & Davis of New York City.

A. P. Davis, former chief engineer and general manager of the East Bay Municipal Utility District, of Oakland, Berkley and Alameda, Calif., has been appointed by the Russian government to supervise a $250,000,000 irrigation project, the largest single undertaking of its kind in modern times.

Hugh M. Beugler has recently become associated with the E. Y. Sayer Engineering Corporation of New York City in connection with the development of various engineering and construction projects. For many years Mr. Beugler has been engaged in public utility work. He was formerly general superintendent of construction for Day & Zimmerman, operating superintendent on properties of the American Cities Company, and operating manager of the Central Hudson Gas & Electric Corporation.

Charles Grunsky has resigned as gas and electric engineer of the California Railroad Commission to accept a position as supervising engineer with the new management and engineering company being formed to direct the activities of the Pacific Public Service Corporation.

Charles R. Bartholet has been named Washington State Supervisor of Hydraulics to succeed R. K. Tiffany, resigned. Mr. Tiffany was recently appointed by President Hoover a member of the federal commission on reclamation and development of public lands.

Business Notes

Babcock-Wilcox & Goldie McCulloch, Ltd., of Montreal, Canada, announce the removal of their Montreal office from the St. Henry to the Canada Cement Building. All correspondence should be addressed to General Post Office Box No. 3040.

Chicago Pump Company, Chicago, Ill., announces the addition of F. W. Forward, 520 West Blvd., Elkhart, Ind., to its list of representatives.

Chain Belt Company, Milwaukee, Wis., has recently appointed five new distributors of chains and transmission equipment, as follows: Bailey-Lebby Company, Charleston, S. C.; Georgia Supply Company of Savannah, Ga., and Jacksonville, Fla.; Harry P. Leu Company, Orlando, Fla.; J. M. Tull Rubber & Supply Company, Atlanta, Ga.

Allis-Chalmers Manufacturing Company, Milwaukee, Wis., announces the appointment of the T. B. Wood's Sons Company, Chambersburg, Pa., as special distributors of its rope drives and belts.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., announces the appointment of Thomas Fuller as manager of the Atlanta district office to succeed H. A. Coles, deceased. Mr. Fuller was formerly manager of the Charlotte, N. C., office, and has been prominently identified with the electrical industry in the South.

Pangborn Corporation, Hagerstown, Md., is celebrating its 25th anniversary this year, and has prepared an attractive folder telling briefly of the accomplishments of the company.

Stratton Engineering Corporation, New York City, announces that C. R. Matheny, formerly New York district manager of the Hagan Corporation, has joined its sales staff.

Trade Catalogs

Engineering—W. S. Barstow & Company, 50 Pine St., New York City, in a new publication of the company, tells about some of the power plants they have recently designed and constructed. Numerous illustrations of the plants add to the interest of this bulletin.

Welding—Bulletin 104, of Tube Turns, Inc., Louisville, Ky., sets forth the use of seamless drawn fittings for pipe welding and welding itself in the petroleum and process industries. The 20-page booklet contains many illustrations, layout plans, a chart of friction losses and specification tables.

Gears—"It Pays to Use Westinghouse-Nuttall Heat-Treated and Hardened Gears," is the title of folder No. 5223, recently issued by the Westinghouse Electric & Manufacturing Company, of East Pittsburgh, Pa. The folder contains a tabulation of physical properties of heat-treated and untreated gears and curves showing relative hardness in gear teeth.

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Noise Abatement — The first copy of "Isolation," a quarterly publication devoted to the scientific, practical and economical application and study of materials and methods of deadening and eliminating vibration and noise, has just been issued by the Korfund Company, Inc., 235 East 42nd St., New York City. It contains interesting articles on noise abatement in buildings, factories and power plants.

Electrical Devices — General Electric Company, Schenectady, N. Y., has just issued the following catalogs of electrical equipment: GEA-1155 and 1156, on single- and three-phase induction regulators; GEA-1006B, on concentrated-system control of switching equipment; GEA-704B, 834A and 948A, on circuit breakers and controllers; GEA-1183, on alternating-current watt-hour meters; GEA-1151, on mercury-arc rectifiers for railway service; and GEA-569C, on constant-potential arc-welding motor-generator sets.

With the Society Sections

A.S.M.E., Charlotte Section. Combined meeting with the Charlotte Engineers Club, Dec. 9, as guests of the Duke Power Company for luncheon and inspection of the new Riverbend Steam Station on the Catawba River.

A.S.M.E., Ontario Section. Meeting, Dec. 11, Galt, Ont., at 7:30 p.m. Subject: "Vertical Air Compressors," by Georg Oman of the Babcock-Wilcox & Goldie-McCulloch Company. A trip through the Babcock plant in the afternoon and dinner in Galt will precede the address in the evening.

A.S.M.E., San Francisco Section. Meeting, Dec. 5, at the San Francisco Engineers Club at 7:30 p.m. Subject: "Steam Turbine Lubrication," by A. J. Turner, Standard Oil Company of California.

A. S. H. & V. E., Boston Chapter. Meeting, Dec. 9. Subject: "Recent Development in the Control of Direct Steam Heating," by Webster Tallmadge, steam specialist, of New York City.

A. I. E. E., New York Section. Power Group Meeting, Dec. 9, Engineering Societies Building at 7:30 p.m. Subject: "Power System Connections."

Power Transmission Association. Annual meeting at the Commodore Hotel, New York City, Dec. 4, at 10 a.m. The meeting will include a luncheon and a conference of pulley manufacturers in the afternoon.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.15 @ $2.50
Kanawha	Columbus	1.30 @ 1.60
Smokeless	Cincinnati	2.00 @ 2.25
Smokeless	Chicago	2.00 @ 2.25
S. E. Kentucky	Chicago	1.30 @ 1.60
Steam	Pittsburgh	1.50 @ 1.80
Gas Slack	Pittsburgh	1.00 @ 1.15
Big Seam	Birmingham	1.25 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$3.00
Barley	New York	1.35@ 1.50

FUEL OIL

New York—Nov. 21, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Nov. 12, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.596 per bbl. or 42 gal.; 26@28 deg., $1.646 per bbl.; 28@30 deg., $1.696 per bbl.; 30@32 deg., $1.746 per bbl.; 32@36 deg., gas oil, 5.026c. per gal.; 37@40 deg., distillate, 5.748c.

Pittsburgh—Nov. 12, f.o.b. local refinery, 30@34 deg., fuel oil, 4.87½c. per gal.; 36@40 deg., 5.12½c. per gal.

Philadelphia—Nov. 15, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — Nov. 12, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Nov. 16, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 95c.@$1.00 per bbl.; 30@32 deg., $1.20 per bbl.

Boston—Nov. 18, tank-car lots, f.o.b., 12@14 deg., Baumé 4.25c. per gal.; 28@32 deg., 5.5c. per gal.

Dallas—Nov. 16, f.o.b. local refinery 26@30 deg., $1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Modesto—Pacific Gas & Electric Co., 245 Market St., San Francisco, is having plans prepared for the construction of a power plant here. Estimated cost including equipment, $200,000. Private plans.

Calif., Riverside—County Water Works Dist. No. 1, plans an election to vote $650,000 bonds for waterworks improvements including wells, pumps, motors, etc. A. C. Fulmor, is county surveyor.

Calif., Robbins—Christenson & Sons, Route 3, Yuba City, plans the construction of a pumping plant, 5,940 g.p.m. capacity in connection with small irrigation project.

Ga., Atlanta — United States Cold Storage Warehouse Co., 2101 West Pershing Rd., Chicago, Ill., plans the construction of a 22 story office building and cold storage warehouse here. Estimated cost $2,000,000.

Conn., Milford — Continental Airports, Inc., R. Sherman Bldg., New Haven, is having plans prepared for the construction of an airport including administration building, hangar, shops, central heating plant, etc. here. Estimated cost to exceed $150,000. H. E. Baldwin, 70 College St., New Haven, is architect. Wynne & Hahn, 902 Chapel St., New Haven, are engineers.

Ind., Evansville—Bd. of Trustees, Waterworks Dept., J. C. Males, Secy., will receive bids until Dec. 5, for extensions and improvements to waterworks pumping station. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., are engineers.

Mass., East Braintree (mail Braintree)—Old Colony Gas Co., Quincy Ave., is receiving bids for the construction of an engine room. Silesbee & Gould, 1 Court St., Boston, are engineers.

Mass., Fall River—Fall River Electric Light Co., R. F. Whitney, Gen. Mgr., plans the construction of a power sub-station at Dwolly and Fenner Sts. New England Construction Co., 89 Broad St., Boston, is engineer.

Mass., Tewksbury—New England Power Co., 89 Broad St., Boston, awarded contract for the construction of switch station buildings and switch station addition to New England Power Construction Co., 89 Broad St., Boston. Estimated cost $2,000,000.

Mass., Worcester—Boston & Maine R.R. Co., North Station, Boston, awarded contract for the construction of a 500 ton automatic electric locomotive coaling and sanding plant here to Roberts & Schaefer Co., 400 North Michigan Ave., Chicago, Ill. W. J. Backes, Boston, Ch. Engr.

Mich., Blissfield—City awarded contract for the substructure of filtration plant and pumping station in connection with waterworks, to J. C. Sherrick Co., 1219 Jefferson Ave., Toledo, O. Estimated cost $50,000. Superstructure to be done by town forces. Contract for pumping equipment not yet let.

Mich., Dearborn—Ford Motor Co., is having plans prepared for the construction of a hotel in connection with airport to include steam heating and refrigeration systems, boilers, elevators, etc., on Oakwood Blvd. $500,000. A. Kahn, 1000 Marquette Bldg., Detroit, is architect. Also receiving bids for the construction screen house for power plant intake tunnel at River Rouge. Giffels & Vallet, 604 Marquette Bldg., Detroit, are engineers.

Neb., Lincoln — U. S. Veterans' Bureau, Arlington Bldg., Washington, D. C., will receive bids until Dec. 31, for the construction of a group of buildings including boiler plant, refrigeration and ice making plant for U. S. Veterans' Hospital, Lincoln, Neb.

N. J., West Paterson—Borough Council, S. T. Edge, Clk., will receive bids until Dec. 6, for the construction of a pumping station, also laying force main.

N. Y., New York—United Electric Light & Power Co., 130 East 15th St., awarded contract for the construction of a boiler plant at 134th St. and Locust Ave. to Ken Well Contracting Co., 145 East 14th St. Estimated cost $400,000.

Pa., Pittsburgh—Duquesne Light Co., granted permit for the construction of a water treatment plant and pump house including circulating and water treating pumps, etc. at Brunots Island. Estimated cost $290,000. Byllesby Engineering & Management Corp., 435 6th Ave., is engineer.

Pa., Polk—Polk State School, H. M. Watkins, Supt., received lowest bid for improvements to power house consisting of new engine, generator units and appurtenances from Elliott Co., Morris Bldg., Philadelphia. $41,352.

Tex., Amarillo — Commonwealth Corp., c/o Southwest Public Service Co., D. D. Farrell, Gen. Mgr., awarded contract for the construction of a power plant, to C. S. Lambie Construction Co., Amarillo. Estimated cost $85,000.

Tex., Coleman — Banner Ice & Ice Cream Mfg. Co., awarded contract for the construction of a 20 ton ice plant, electrically operated to Edgerton & Furrey, Coleman. Estimated cost $45,000.

Tex., Coleman—City, F. W. Taylor, Comr., is having preliminary plans prepared for the construction of an ice plant. Estimated cost $125,000.

Tex., San Antonio—Southwestern Bell Telephone Co., c/o H. Martyn, Local Mgr., is receiving bids for foundation and basement, for an 8 story administration and equipment building, including power and heating plant, elevators, etc., on Martin St. Estimated cost $2,500,000. Private plans. Bids for superstructure, etc., will be received about Jan. 1.

Tex., Yoakum—Swift & Co., 33 South Clark St., Chicago, Ill., awarded contract for the construction of a 75 x 110 ft. cold storage plant here to J. T. Taylor, First National Bank Bldg., Ft. Worth. Estimated cost $50,000.

Wash., Tacoma—City awarded contract for the substructure of a portion of the tailrace for the Cushman power house No. 2, also highway to carry Olympic highway over tailrace to Ward Construction Co., Tacoma. $219,940. Former contract rescinded.

Wash., Tacoma — Port Commission received lowest bid for the construction of a terminal with refrigeration space of 1,000,000 cu.yd. from Puget Sound Bridge & Dredging Co., Central Bldg., Seattle. $240,986.

B. C., Granite Falls—West Kootenay Power Co., Rossland, will build dam on Adams River by owner's forces. $1,250,000. Work to be started in December. Plans under way for power house, machinery and transmission line, $2,750,000. L. A. Campbell, Rossland, is engineer.

B. C., Powell River—Powell River Co. Ltd., Vancouver Island, awarded contract for the construction of a dam, power house, tunnels and pipe line in connection with hydro-electric development on Lois River, 18,000 hp. capacity, to Stuart Cameron & Co. Ltd., 543 Granville St., Vancouver. Estimated cost $2,000,000. Total estimated cost $8,000,000. Other contracts to be let.

B. C., Victoria — Canadian Pacific Ry. Co., Montreal, Que., awarded contract for the construction of a laundry and power house on Douglas St. here, to Carter-Halls-Aldinger & Co., 510 Hastings Ave., Vancouver. Estimated cost $600,000. J. M. R. Fairbairn, Montreal, is chief engineer.

Ont., Bothwell — Bothwell Oil & Gas Co., plans to rebuild power house recently destroyed by fire. Estimated cost $30,000.

Wanted

WALTER WELLS, veteran electrical engineer of the Province of British Columbia died recently on Bowen Island, B. C. Mr. Wells has been well known in the electrical industry of the province for the past 22 years.

ROBERT T. HUSTON, vice-president and superintendent of the Connersville [illegible] died suddenly Nov. 14

[illegible] and installing 600 hp. water tube boiler, stoker feed forced draft stoker, economizer, air preheater and induced draft fan, superheaters, etc. for municipal light and water plant.

Boilers, Stokers, etc. — Lincoln, Neb., City will receive bids about Dec. 1, for two 500 hp. boilers complete with stokers, economizers, soot blowers and superheaters.

Engine—Hinton, Okla.—Hinton Ice Co., F. Wilson, Mgr., plans to purchase a 65 hp. Diesel oil engine.

Engines, etc.—San Francisco, Calif.—Supt. of Lighthouses, plans the installation of one 5 and one 4 ton stiff leg derricks, operated by 40 and 30 hp. 6 cylinder gasoline engines at Anacapa Island Light Station.

Motor, etc.—Washington, D. C.—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Dec. 11 for motor, switches, etc.

Pumps, etc.—Marlow, Okla.—City plans to purchase pumps, etc. for proposed waterworks improvements. Estimated cost $55,000.

Industrial Projects

Calif., Compton—Pacific Iron & Steel Co., 241 East Ave. 26th St., Los Angeles, plans the construction of a 1 and 2 story factory here. Estimated cost $250,000.

Conn., Meriden—International Silver Co., 48 State St., awarded contract for a 1 and 3 story, 55 x 320 ft. factory to Bartlett Brainard Co., 252 Asylum St., Hartford. Estimated cost $100,000.

Conn., Waterbury—Platt Bros & Co., Platts Mills, awarded contract for the construction of a 1 story, 75 x 140 ft. brass rolling mill to C. H. Kinney Co. Inc., 525 Watertown Ave. Estimated cost $42,000.

Ind., Jasper—Hoosier Desk Co. awarded contract for the construction of a 60 x 85 ft. factory to C. Keller, 818 Du Bois, Vincennes. Estimated cost $42,000.

Ind., South Bend—Bendix Brake Co., awarded contract for the construction of a 200 x 300 ft. tool room, 150 x 220 ft. screw machine shop and 150 x 340 ft. steel storage building, to H. G. Christman Co. Estimated cost $450,000.

Ind., South Bend — South Bend Tool Co., awarded contract for the construction of a 35 x 85 ft. factory at 1918 South Main St., to R. Sollitt & Sons. Estimated cost $47,000.

Md., Baltimore—Guilford Folding Box Co., Eager and Fallsway Sts., awarded contract for the construction of a 1 and 2 story factory at Philadelphia Rd. between 30th and 40th Sts. to Consolidated Engineering Co., 20 East Franklin St. Estimated cost $190,000.

Mich., Detroit—Kelsey Wheel Co., 3600 Military Ave., awarded contract for the construction of a 1 story, 135 x 320 ft. addition to wheel plant on Military Ave. to J. A. Utley, 739 Penobscot Bldg. Estimated cost $100,000. Electric motors, etc. will be installed.

N. J., Edgewater—Ford Motor Co., E. Ford, Pres., Highland Park, Mich., awarded contract for the construction of a 2 story, 360 x 1,500 auto assembly plant including boiler house and steam power plant, etc. here to Turner Construction Co., 420 Lexington Ave., New York, N. Y.

N. J., Newark—Sonatron Tube Co., 57 State St., will receive new bids about Jan. 15 for the construction of a 6 story, 68 x 120 ft. factory for the manufacture of radio tubes at 78-82 8th Ave. Estimated cost $175,000. Siegler & Greenberg, 164 Market St., are architects.

N. J., Newark — Westinghouse Electric & Mfg. Co., 17 Academy St., is having plans prepared for the construction of a 2 story factory at State Highway 25 and Haynes Ave. Estimated cost $150,000. B. S. Prack, 119 Federal St., Pittsburgh, Pa., is architect. J. H. and W. C. Ely, 605 Broad St., are consulting architects.

O., Cleveland—J. C. Virden Co., 6009 Longfellow Ave., manufacturers of electric goods awarded contract for a 2 story addition to factory to Griffin Construction Co., Engineers Bank Bldg. Estimated cost $50,000.

O., Cleveland—Willard Storage Battery Co., c/o P. N. Voth, Construction Mgr., 246 East 131st St., awarded contract for a 23 x 40 ft. acetylene plant to Albert M. Higley Co., Plymouth Bldg. Estimated cost $40,000.

Pa., Donora — American Steel & Wire Co., Frick Bldg., Pittsburgh, awarded contract for new stock house at the Blast furnaces new lorry cars and new coke screening equipment here, to A. G. McKee & Co., 2422 Euclid Ave., Cleveland, O. Estimated cost $1,000,000.

Vt., Burlington—T. A. Hiagh Lumber Co., is having plans prepared for the construction of a 2 story, 60 x 100 ft. factory including boiler room, fuel storage room, dry kilns, etc. Estimated cost to exceed $40,000. F. L. Austin, 240 College St., is architect.

Ont., Hamilton—Steel Trough & Machine Co., Ltd., Tweed, is having plans prepared for the construction of a factory for the manufacture of various lines of steel equipment. Estimated cost $50,000. Private plans. Machinery and equipment will be required.

Ont., Leaside—Trane Co. of Canada, Ltd., 439 King St., W., Toronto, plans the construction of a 2 and 3 story factory for the manufacture of heating specialties here. Estimated cost $100,000. Architect not selected.

Ont., Toronto — G. Rathbone Lumber Co., 10 Northcote Ave., plans a 3 story addition to woodworking plant, including a 200 hp. boiler in existing power plant. Estimated cost $150,000. V. L. Morgan & Co., 1454A Yonge St., are architects.